JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOLUME 33 DECEMBER 15, 1943 No. 12

# ENTOMOLOGY.—*Insect taxonomy and principles of speciation.*[1]

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Probably no taxonomic science has been built upon so many conflicting systems and standards as has entomology. There are three apparent reasons for this heterogeneity—the tremendous scope of the science, its long history, and the diversity of approach of its many contributors. Furthermore, during the past few decades it seems to have suffered an era of isolation during which it attained a high degree of specialization and artificiality. The effort to standardize in terms of simple "generic" and "specific" characters, usable in keys, has resulted in great confusion and has considerably obscured the evolutionary picture. Nature, deeply subtle, can not reveal itself fully when examined piecemeal, each part dissected from the whole; and a collection of organisms so classified is therefore apt to reflect merely an arbitrary system in the mind of the worker, and to contribute little toward a comprehension of evolutionary phenomena.

Some of the early naturalists, such as Thomas Say and John L. LeConte, unhampered by conventionalities that have arisen since their time, seem to have had almost an intuitive approach to problems of speciation. Knowingly or not, they worked as if impressed by the more or less qualitative characteristics distinguishing reproductively insulated populations—the true test of specific integrity. They used their judgment and rarely did they commit a serious error. Contrast their relatively sound work with that of turn-of-the-century nomenclators, whose deductive, conventional taxonomy often led to such extremes as the attachment of multitudes of specific names to individual variations and anomalies, worn and bleached specimens, vague geographic races, stages of maturity, and, not infrequently, to the sexes of the same species.

Of recent years, systematic workers have begun to treat insects more as complex, living organisms. They have found it better science to study a relatively few species exhaustively than a large number of miscellaneous species superficially. There has thus accumulated enough evidence in entomology alone to place the species principle on a firm basis of fact, and some hope now dawns that the naming and arranging of insects will reflect the biological forces under which they have evolved. This practice, continued, will tend to produce a simple, flexible taxonomy—one that may eventually bring a gratifying degree of order to a subject now in considerable chaos.

In simplest terms, the species may be defined as a unit population of genetically similar though sometimes outwardly variable organisms that will interbreed freely in their natural habitat. No barrier due to internal factors operates to prevent normal individuals from reproducing. In other words, the species is a clan whose members are compatible psychologically, physiologically, and morphologically. When closely related species of this ideal type are not isolated by spatial or temporal limitations, they are *insulated* from one another as a result of the operation of internal specific systems ("mechanisms"), which may be classified as follows:

1. *Anatomical insulation.* The lock-and-key-like, sclerotized genitalic structures of both sexes, often extremely complex and usually characteristic of the species, tend to restrict successful insemination to within the species.

[1] Received September 25, 1943.

2. *Physiological insulation.* Egg-sperm specificity, i.e., incompatibility between the sexual products of two species as exhibited in resistance to cross fertilization, in abnormality of development, in disturbances of fertility of offspring, etc.

3. *Ethological (behavioristic) insulation.* Specific selectivity, i.e., reluctance under natural conditions to engage in interspecific mating. This may be extended to include ostracism and isolationism of hybrids and anomalies.

The first is hypothetical but doubtless operates to a greater or lesser extent in insects; the second is a possibility that lacks experimental proof in insects; the third, however, is a demonstrable fact not only in insects but in other groups of animals as well. Related species of migratory ducks, for example, traveling in mixed company during the mating period, preserve perfectly their specific integrity in spite of occasional crossing, whereas the same species will hybridize much more freely in confinement. A similar phenomenon occurs in ungulate, carnivorous, and primate mammals. Indeed, it may be said of all closely related and associated species that a most important segregating factor, and perhaps often the *chief* one, is preferential selectivity. This amounts to habitual or instinctive reluctance on the part of an individual to accept for a mate any other individual, presumably of another species, presenting sexual stimuli other than those to which the first has been conditioned. That this specific conditioning can be artificially overcome, at least in the higher vertebrates, has been adequately demonstrated, and there is little reason to doubt that, in like manner, ethological (social) interspecific avoidances between related and associated species of insects will also tend to dissolve as a result of selective confinement under laboratory conditions.

From a general survey over the whole compass of speciation, beginning with minor, local variants and culminating with very distinctive aberrant species (many monobasic genera), it is at once obvious that the gradient is not a simple, gradual one but is beset with numerous plateaus and peaks that represent categories into which various kinds of "species" may be roughly classified. Further analysis reveals a rather distinct split of the entire picture into two curves, which are more or less superimposed at their bases. The object of the present paper is to compare these two major categories in their purest form in an effort to detect a possible fundamental, causal difference that might justify a clear-cut taxonomic interpretation.

In groups of plastic organisms exhibiting an abundance of valid species, it is a common phenomenon to find the most similar forms (perhaps those of most recent origin) living in closest ecological proximity. This is well illustrated in the Coleoptera, where species closest of kin very often live in intimate association, providing evidence that environmental segregation in these cases may be virtually ruled out as a functional isolating mechanism. Very similar and apparently congenetic species of Carabidae, for example, commonly share the same micro-habitats, nor is there any reason to believe that in most instances their respective breeding seasons do not at least overlap. Two and even three species of cave beetles (*Pseudanophthalmus*), showing extremely close affinity yet representing unquestionably distinct forms, repeatedly have been taken running together in the same cave or cave system in which they are localized. To cite another example, out of an almost inexhaustible field, certain species of archaic, flightless weevils (*Proterhinus*) in the Hawaiian Islands are proximate not only in kinship but in habits as well, being found together on identical host plants. Very closely related but discrete species not infrequently occur in pairs and occupy the same macro- and micro-ranges. Familiar examples among the carabids are *Calosoma scrutator* (F.) and *C. willcoxi* LeC., *Scarites subterraneus* F. and *S. substriatus* Hald., and *Galerita janus* F. and *G. bicolor* Drury.

Such species automatically receive the acid test of integrity since, in the natural state, they habitually refuse to cross with their related associates although there is no apparent lack of opportunity. The separating factor appears to be essentially an internal one—a specific "awareness" or recognition of kind. Furthermore, the phenomenon is suggestive of an intrapopulational

origin of an important class of species which may owe their existence, in large measure, to self-restricting conditionings, sexual and social, within the morphological (mutational?) range of the population. Indeed, it can be maintained that speciation of this type is fundamentally psychophysiological. At least, when once it is started there is no reason to suppose that it can not be sustained by autoselectivity over and above any help from anatomical incompatibilities that may have arisen during the course of speciation. Although the first-stage products are not always easy to distinguish taxonomically, careful study usually reveals separating characters that are multiple and localized rather than generalized, constant rather than fluctuating, and qualitative rather than quantitative. Oftener than not, drastic changes in male genitalia, of a higher order than the usual variations in this plastic structure, give the clue to such specific dichotomy.

Unfortunately, there is a current tendency on the part of biologists to treat genitalic barriers merely as another "isolating mechanism" on a par with environmental segregation. Perhaps it would be well to bear in mind that these distinctive anatomic features are, after all, part of the speciation phenomenon itself. It is confusing, if not illogical, to accept the results of a biological process as their own initial cause. To clarify the problem one must proceed further with the analysis. Although the genitalic dissimilarities that tend to insulate related forms may contribute to the "purification" of a species, they should, in the writer's opinion, be viewed also as part of the consequences of a far more intrinsic and complex biogenic process with roots deep in the behavioristic psychology and sexual interactions of organisms. Perhaps it is not too extreme a view to hold that true speciation, a phenomenon not encountered in the intricate divergences of parthenogenetic forms, or in the plastic instability of asexually reproducing lower organisms, is essentially correlated with sex. More completely, it is the liberation of discrete morphological momenta, which are to some extent sustained and directed by the attractions, aversions, and compatibilities of organisms, but on which these psychophysiological momenta or conditionings are to the same degree dependent.

In antithetic contrast to associative speciation is dissociative raciation, the products of which are customarily (but very possibly inaccurately) termed "subspecies." Typical raciation, as has often been pointed out, is the effect on a species of an external factor—environmental segregation. This operates principally to circumscribe specialized adaptive salients and to establish genetic strains much as would selection. The segregating agency, always circumstantial, is usually secular (geographical, ecological, or temporal), though occasionally it is biological, as in the case of parthenogenetic forms whose various lines become isolated by virtue of their inability to cross. The ideal picture of raciation is one in which autoselectivity is notably absent, the local populations, or races, hybridizing freely where ranges overlap. They differ from true species in that they tend to exhibit distinguishing characters that are relatively superficial, generalized, quantitative and fluctuating. Even when, in extreme raciation, the changes taking place may pervade the entire facies to such an extent as to appear of qualitative value, they may usually be interpreted as alterations in degree rather than in kind, since no new character is ordinarily involved. Assuming, as seems permissible from the available evidence in Coleoptera, that totally different factors enter into the origin of associative species and dissociative races, it is not unreasonable to suppose that the observable differences between the two categories reflect on the one hand the relatively internal nature of the speciating "drives" in contrast to the relatively external mechanism of raciation on the other.

The two processes, though dissimilar in principle, are not, however, mutually exclusive, and long-continued isolation of sister colonies might conceivably result in potential speciocentrism demonstrable as refusal to cross when the opportunity arrives. It is true that in cases of discontinuous geographical raciation, and of raciation due to abrupt adaptation to environmental differences, populations sometimes exhibit such conspicuous departure from ancestral type

as to render their specific or racial status a matter of considerable question. The taxonomic problems that thus arise are admittedly often very difficult; but in the writer's experience indecision is due oftener to an inadequate knowledge of the species in its entirety than to the unavailability of valid evidence.

In the Caraboidea, geographically discontinuous or "spotty" distribution of a species is the exception rather than the rule, discounting, of course, the clearly obligatory type of segregation such as that imposed by insular, mountain-top, and cave life. Nor does the condition involving obligatory segregation necessarily correlate with increased taxonomic confusion. In cavernicolous faunas, for instance, it is surprising how trivial are the observable differences between colonies of widely ranging species of cave beetles (*Pseudanophthalmus*) isolated in individual caves over a subterranean system scores or even hundreds of miles in extent—a phenomenon in distinct contrast to the unmistakable, nonoverlapping distinctions between related species in the same cave. It is more than likely that most of these populations have had an extremely long history of isolation; yet a recent survey of the genus has shown that there are remarkably few forms that can not immediately be assigned either specific or racial rank.

Products of mountain-top isolation often exhibit similar conservatism. The following is a typical example: *Steniridia aeneicollis* (Beutenmüller) and *S. tricarinata* Casey are very closely related "species" of an ancient stock of cychrine carabids endemic to the Appalachian region south of glaciation. These two forms are at present restricted to the forests above an altitude of about 4,000 feet, respectively, in the Black and Pisgah-Balsam-Smoky Mountain Ranges of North Carolina and Tennessee. In their consistent and distinct differences, and in their inability or unwillingness to traverse the extensive surrounding valleys, they stand out as conspicuous isolation products in an otherwise itinerant group containing five clear-cut species whose comparatively wide ranges broadly overlap. At least two of these species ascend the mountains sufficiently high to live in association with the two summit-dwelling relicts. If we consider the latter as a single species, the characters that separate all six are trenchant and multiple, involving drastic genitalic and tarsal modifications; whereas the relicts differ one from the other only quantitatively, in minor changes of contour, development of the interstrial costae, and suppression of sclerotization in the transfer apparatus of the male copulatory organ. They represent a distinctly lower order of mutual divergence than do their associated relatives of higher rank, despite the probability that these extreme orophilic forms have had the longtime "advantage" of complete isolation from each other.

Insular races often seem to be stabilized by a similar evolutionary inertia. An experiment performed by the writer illustrates this rather clearly. A tiger beetle, *Cicindela vitiensis* Blanchard, inhabiting the larger Fiji Islands, is both abundant and ubiquitous throughout its range. Each large island and each of a variety of overlapping ecological frames furnishes its distinctive race or subrace. For many years *vitiensis* has been considered the only tiger beetle in Fiji. Not long ago, however, the writer discovered a local, mountain-dwelling colony of another cicindelid living in intimate association with *vitiensis* but apparently not hybridizing with it. The new form exhibits qualitative specializations of characters present in *vitiensis* that establish without doubt its status as a distinct species as well as its probable origin from *vitiensis*. Interspecific copulation tests under laboratory conditions gave the following results: With equal numbers of each sex of both species present, out of 38 matings observed, only 3 were interspecific. The latter were abortive, recognition apparently causing premature separation. Psychological insulation of this order coupled with probable physiological and morphological barriers could easily account for the genetic preservation of the species, while the fact that specific selectivity in mating was not found to be absolute merely confirms the closeness of the relationship. These data contrast strikingly with those resulting from a similar experiment in which two geographic races of *vitiensis*, differing

quantitatively chiefly in respect to color pattern, were brought together—the Vitilevu race (*vitiensis* s. str.) used in the above tests, and another (*v. imperfecta* Horn) inhabiting the island of Taveuni 100 miles distant. Out of 121 matings observed in cages containing equal numbers of both sexes of the two races, 59, or almost exactly half, were interracial.

It may well be that raciation under certain circumstances, such as at the extremes of extensive, divergent clines, can proceed to the point of potential insulation tantamount to speciation. Indeed, there is some evidence to this effect; yet the basic concept of speciation through biogenic discontinuity is not invalidated thereby. Fulfillment of the species standard would still depend, in the last analysis, upon the natural association of diverging groups and the spontaneous building up of an internal block between them. All the indications are that, if there is a potential split, interracial aversions must actuate the final disunity and determine its permanence. One would therefore expect speciation by raciation to be, at most, atypical, since isolation, the one factor most responsible for raciation, precludes association, the one condition essential to a true test of speciation. For example, the most distinctive races of caraboids, and consequently those most likely to establish species, occupy relatively restricted ranges, to which they are often secured by adaptive and sedentary instinct, or confined by actual physical barriers. Although negative, evidence arising from this relationship militates strongly against a total explanation of speciation in terms of raciation. On the other hand, gradual eradication of ecological and geographic obstacles over considerable geologic time, followed by colonization of available areas, could and probably has played an important part in the union of isolated races; but there seems to be no more evidence that races thus thrown together will take a specific stand than there is that they will cross. Field data from various sources, including vertebrate as well as invertebrate groups, have shown both to be possibilities. Probably significant, however, is the relative scarcity of observed instances of insulation between merging races in contrast to the abundance of cases illustrative of closely related and associated species exhibiting little or no indication of raciation, past or present. It is therefore difficult to escape the conclusion that intolerance of the unfamiliar, regardless of mode of origin or apparent tangibility of the departure, is a more fundamental factor in true speciation than isolation, which does not necessarily contribute to the establishment of distinctions appreciable to the organism.

Radical speciation apparently resulting from ancient and complete isolation may, in some cases, be interpreted as the survival of the more specialized of two or more congenetic and possibly competing species. It does not seem necessary, however, to assume extinction of the more conservative, ancestral forms to account for drastically distinct endemics, since it is well known that species confined to small areas, particularly to small islands, often fail to meet the usual specific standards of consistency established by free-ranging continental forms. Their variability, or "fluidity," may be a direct result of a sedentary life, or it may be due to the entrapment of genetic strains, or to both, but whatever the origin such a plastic potential must function as the ideal set-up for divergent speciation of the true associative type involving not only the new products but the more conservative progenitors as well. In the Carabidae, at least, endemic faunas of circumscribed ranges are largely made up either of obvious races or of compact groups of many species. The much rarer instances of single species occupying isolated ranges usually fall into the category of geologically antique, aberrant residua of one-time flourishing evolutionary tangents.

In summary, the results of an analysis of the species problem as presented by studies in various groups of the Caraboidea indicate that speciation may be defined as relatively complete morphogenic (mutational?) departure sanctioned and channelized by psychophysiological conditioning; and that raciation, a process involving environmental closeting, is the establishment of genetic lines, adaptive or fortuitous, that are essentially superficial and devoid of internal, insulating organization. The two do

not appear mutually dependent, nor are they mutually exclusive. Whether raciation attains the species level depends upon the synchronous introduction of antipathetic responses between two or more merging races formerly spatially remote, an event that certainly is possible but, supported as it is by very few factual data, is probably atypical. Whether or not the species level is maintained depends largely upon the degree of fixation of an internal "awareness" whose sporadic involution in related associates may cause occasional anastomoses in the dichotomous tree of normally repellent, discrete evolution. Endless shifting circumstances, such as bring about sequestration, changing habits and locale, introduction of new faunistic elements, adoption of the parthenogenetic method of reproduction, etc., may mask the history of a species, its origin, deployment, and restriction, but so indelible is the nucleus of specific character that the relatively minor alterations due to change of life seldom, if ever, succeed in eradicating the stamp beyond recognition. All things considered, it is probably not too extreme a view to hold that sexual reproduction, together with at least initial association of divergent elements, is a *sine qua non* of the actual process of true speciation.

From the foregoing, two fundamental evolutionary principles suggest themselves: (1) True species may not be essentially dependent upon isolation for their origin; (2) secular isolation, though correlated with differentiation, may not by itself be a primary speciating factor. Speciation often appears to be the spontaneous introduction of new, self-insulating units within a parent-species population; it is the end product of self-augmenting, biogenic momenta involving the organism in its entirety. Typical raciation, on the other hand, is the effect on the species of group segregation, a factor imposed from without and operating disinterestedly in much the same manner as natural selection. To evaluate the mixed products of these two processes is the chief concern of taxonomy, a science whose complexity increases with the plasticity, youth, and colonizing drive of the group under consideration.

The scope of entomological taxonomy is so vast that the experimental approach to all its problems is out of the question. However, if good judgment based on carefully studied models takes the place of indiscriminate key-character hunting, great strides can be expected toward a system that will reflect evolution. A supposed new species should in every instance be subjected to a critical analysis, both as to the nature of its distinctions and as to the spatial relationships existing between it and its nearest allies. If these criteria were universally applied, systematics would gain immeasurably in significance, for it would then portray evolution in such a manner as to bring out not merely degrees of differences but *kinds* of differences as well.

GEOLOGY.—*The paleontology and stratigraphy of the upper Martinsburg formation of Massanutten Mountain, Virginia.*[1] MARK H. SECRIST and WILLIAM R. EVITT, The Johns Hopkins University. (Communicated by E. W. BERRY.)

During the course of field work on Silurian stratigraphy, Dr. Charles K. Swartz found what at first was thought to be a new species of the gastropod *Lophospira* in the upper part of the Ordovician Martinsburg formation in the Massanutten Mountain region of Virginia. In order to determine the significance of this fossil, Dr. Swartz approached the senior author, who has been engaged for some years in a study of the general problems concerning the stratigraphy and fauna of the Martinsburg, assisted, since the summer of 1941, by the junior author. As a result of this inquiry, a study was made not only of the section in which Dr. Swartz found the gastropod in question but also of another section somewhat farther south. The material collected has yielded ten new species of gastropods, pelecypods, and brachiopods. It has become evident that both the fauna and the lithology of the upper Martinsburg in these eastern sections indicate conditions different from those represented by the upper Martinsburg farther to the west and south.

[1] Received July 12, 1943.

Studies of intermediate regions are not sufficiently advanced to allow correlations between eastern and western areas to be included in this paper. We shall limit ourselves to a description of the new species and a statement of the evidence and conditions as they exist in the field and shall make definite correlations only between the two sections investigated in Massanutten Mountain.

*Location and extent.*—The area covered in this report lies in the Massanutten Mountain region of the Appalachian Valley Province of Virginia. This mountain is a large monadnock that projects from the floor of the Shenandoah Valley and extends about 50 miles in a northeast-southwest direction. The mountain itself is double, composed of two roughly parallel ridges, which are the limbs of a synclinal fold in the Paleozoic rocks, the more resistant formations of which have withstood to a greater degree the processes of erosion that have leveled the less resistant early Paleozoic limestones to form the broad, flat floor of the valley. The mountain divides this valley into a western part and an eastern part, which are occupied, respectively, by the North and South Forks of the Shenandoah River. New Market Gap, in Shenandoah and Page Counties, is the only large gap that cuts across the mountain, though several smaller gaps offer passage for unimproved country roads.

The outcrops studied occur in two localities: (1) along the road near the northern end of Passage Creek Valley in Warren County, extending for a distance of 710 feet (road distance) northward from the contact with the overlying Massanutten sandstone; and (2) about 40 miles to the south, along the Catharine Furnace Road on the north side of Cub Run in Page County, extending eastward 1,350 feet (road distance) from the contact with the Massanutten sandstone. Passage Creek drains the minor valley between the two ridges of Massanutten Mountain, having its headwaters north of New Market Gap. It flows northeastward and empties into the North Fork of the Shenandoah River east of Waterlick, just beyond the northern end of the mountain. Cub Run is a small stream flowing northward and eastward into the South Fork of the Shenandoah River a few miles south of Newport in Page County.

*Underlying formation.*—The Martinsburg formation, where observed in the Massanutten region, is underlain conformably by the Chambersburg limestone. In this section of Virginia we have recognized four lithologic divisions of the latter: (1) comparatively massive, impure limestone with several thin beds of bentonite near the base; (2) nodular, thin-bedded, argillaceous limestone; (3) a zone of blue limestone in beds 12 to 18 inches thick separated by thin beds of shale; followed gradationally by (4) the upper part of the formation, which, in the unweathered state, consists of compact, medium-bedded, impure limestone with numerous clay partings causing it to weather into thin sheetlike layers. The transition from this last zone into buff-weathering, preponderantly argillaceous lower Martinsburg is relatively abrupt. Zones (1) and (4) are well exposed at Cub Run, though at Passage Creek the entire Chambersburg formation is concealed. However, a complete section of the formation is exposed along Tumbling Run on the Lee Highway 2 miles southwest of Strasburg and about 5 miles west of Passage Creek.

*Overlying formation.*—The contact of the Martinsburg and the overlying Massanutten sandstone was not observed, but the concealed interval in which it occurs at both places amounts to only a few feet. The Massanutten formation is a massively bedded, white to gray sandstone and quartzite, conspicuously cross-bedded and very resistant, causing it to form prominent cliffs whose talus slopes invariably conceal the contact with the underlying Martinsburg. At Cub Run conglomerate beds with pebbles an inch or more in diameter are common. At Passage Creek the average grain size is much smaller. The contrast in the lithology of the two formations is everywhere a striking feature.

*Regional and structural relationships.*—A broad picture of the Martinsburg in the entire Massanutten Mountain area indicates that the upper part has experienced very little change, though the middle and lower portions have suffered both structural and

lithologic modification in the northern, northeastern, and western parts of the region. In the Cub Run section, on the contrary, very little alteration or deformation is evidenced.

An accurate determination of the thickness of the Martinsburg in the Massanutten region is impractical (see Butts, 1933, p. 21). Our measurements of sections farther west and south at Monterey Mountain, Catawba Mountain, Narrows, and McCalls Gap, for example, give thicknesses ranging from 1,400 to 2,200 feet. As a result of general field observations, we think the apparently much greater thickness in the Massanutten Mountain region is due to structural readjustments within the formation as visibly expressed by folding, faulting, and lithologic deformation.

*Lithologic description of the Martinsburg formation.*—In the Massanutten area, the Martinsburg formation is not exposed sufficiently for continuous investigation. At Passage Creek outcrops suitable for stratigraphic and faunal studies are restricted to the upper part of the formation. The lower part, where exposed, shows the results of structural and lithologic deformation. At Cub Run exposures are continuous from the massive Massanutten sandstone through the arenaceous upper Martinsburg and well down into the argillaceous middle portion, below which they are intermittent and of irregular extent into the underlying Chambersburg limestone. The following description is based largely upon the Cub Run section:

The gradation from the argillaceous limestone of the upper Chambersburg into the calcareous shale of the lower Martinsburg is fairly rapid. Weathering of the calcareous material results in a yellow to tan or buff color that is typical of the lower and middle portions of the formation. Ascending, the beds become increasingly argillaceous with the advent of arenaceous material in the middle portion. Toward the upper part of the latter, sandstone beds for the first time become prominently abundant. The gradation from the middle portion into the upper is marked lithologically by a change from dominantly argillaceous to dominantly arenaceous beds (Bassler, 1919, p. 156). Corresponding to this lithologic change occurs the faunal change described below.

As shown in the measured sections, the upper portion, characterized by an essentially Maysville fauna, consists mostly of brown, iron-stained, fine-grained sandstone beds of variable thickness with some shaly partings. Cross-bedding is rather general, especially toward the top. Much of the sandstone contains flakes of mica and hematite and flat inclusions of slaty shale up to an inch in size. In addition, being somewhat arkosic in nature, it has a speckled appearance.

*Faunal description of the Martinsburg formation.*—Investigators of these rocks have recognized a threefold faunal division, namely, (1) an essentially Trenton fauna in the lower part, (2) an Eden fauna in the middle part, and (3) a Maysville fauna in the upper part. Thorough investigations have been made in the classic Cincinnati area where the terms "Eden" and "Maysville" have become well established through long usage. In the Cincinnati area, the Trenton is recognized as a well-defined time and lithologic unit. As these formations are followed eastward, the distinctions between the Trenton and the Cincinnatian, on the one hand, and between the members of the Cincinnatian, on the other, become less marked. In large measure the three lose their individualities and more or less combine into a whole which is known to the east as the Martinsburg formation. Our studies in the western and southern parts of the Appalachian Province of Virginia and extending northward into Pennsylvania show that, on both lithologic and faunal grounds, several divisions of the Martinsburg exist, for which, tentatively, we are using the three classic terms "Trenton," "Eden," and "Maysville" (Bassler, 1919, p. 163), pending the results of more complete study.

Inasmuch as the purpose of this investigation was to establish the relationships and significance of the upper Martinsburg, a detailed study was not made of the middle and lower portions in the Massanutten region. At Passage Creek only the upper or Maysville part of the formation is available for study. At Cub Run, on the other hand, both the upper and a considerable thickness of

the middle or Eden portions are well exposed.

The following fossils, all well-recognized Eden representatives (Bassler, 1919, p. 169), establish the identity of the Eden portion at Cub Run: *Aspidopora* cf. A. *newberryi* (Nicholson), *Pholidops cincinnatiensis* Hall, *Sowerbyella sericeus* (Sowerby) var., *Hormotoma gracilis* (Hall), *Cryptolithus tesselatus* Green, and *Ceratopsis chambersi* Miller.

On the other hand, the Maysville at both Passage Creek and Cub Run is recognized not so much by individual species as by a general faunal assemblage (Bassler, 1919, p. 170), which includes species of the following:

BRACHIOPODS: *Dalmanella, Lingula, Orthorhynchula, Plectorthis, Rafinesquina, Zygospira.* PELECYPODS: *Byssonychia, Colpomya, Ctenodonta, Cuneamya, Cymatonota, Cyrtodonta, Ischyrodonta, Orthodesma, Pterinea, Rhytimya, Whitella.* GASTROPODS: *Liospira, Lophospira, Oxydiscus.* CEPHALOPODS: *Paractinoceras, Spyroceras.* TRILOBITES: *Calymene, Isotelus.* OSTRACOD: *Drepanella.*

In contrast to the Maysville of our western sections, there is evidence of only one distinct faunal zone at Passage Creek and Cub Run. Because of its excellent development at the former locality, we have called it the Passage Creek Zone. This zone, at both localities, may be recognized readily by the presence of several abundantly fossiliferous and conspicuously iron-stained horizons, which weather into a porous condition. In the foregoing fossil list of Maysville forms, the only genera that have not been found in the Passage Creek Zone are *Lingula* and *Oxydiscus.*

Very few and scattered fossils were found in the increasingly arenaceous beds of the upper portion above the Passage Creek Zone. Among these are the following: *Buthotrephis* cf. *flexuosa* Hall, *Palaeophycus* sp., *Lingula* sp.

The upper 96 feet of the exposed section at Cub Run have produced no fossils.

*Discussion.*—The Eden at Cub Run is comparable in lithology and fauna to the shaly Eden of the western sections. The general fossil representation in the Maysville, however, is meager; pelecypods and gastropods predominate with a relative scarcity of brachiopods and trilobites in contrast to their abundance in the argillaceous and calcareous material of comparable age farther west. The following, which are associated with the Maysville elsewhere, were not found at either of the Massanutten localities: *Platystrophia* sp., *Hebertella* sp., abundant Bryozoa, phosphatic masses (Butts, 1940, p. 208).

According to Butts (1933, p. 22), the Maysville is characterized "by the profuse and universal occurrence at the very top of *Orthorhynchula linneyi.*" Bassler (1919, pp. 168, 170), in contrast, states: "This *Ortho-*

CUB RUN SECTION

| Thickness | | | Description |
|---|---|---|---|
| Total | Interval | Horizon | |
| — | — | 242.1 | Contact with Massanutten sandstone. |
| 242.1 | 95.3 | — | Barren, massively bedded sandstone, rust-stained and prominently jointed. |
| — | — | 146.8 | Highest bed containing plant remains. |
| — | — | 129.2 | *Lingula* cf. L. *nickelsi* Bassler. |
| 146.8 | 36.9 | — | Moderately cross-bedded, medium to fine-grained sandstone. |
| — | — | 109.9 | Highest gastropod (*Lophospira* sp. indet.). |
| — | — | 90.7 | Highest abundantly fossiliferous bed, 2 to 3 inches thick: argillaceous sandstone, weathering reddish brown (*Colpomya faba* cf. *C. pucilla* Foerste). |
| 109.9 | 49.6 | — | Shale beds becoming less frequent and thinner. Sandstone generally lighter in color. Cross-bedding more evident. |
| — | — | 60.3 | Highest Passage Creek fauna bed. |
| 60.3 | 17.0 | — | Passage Creek Zone consists of fossiliferous, rotten, rusty-brown lenses in and between heavier sandstone beds. *Lophospira, Rafinesquina,* and *Paractinoceras* abundant. |
| — | — | 43.3 | Lowest Passage Creek fauna bed. |
| 43.3 | 11.0 | — | Heavy sandstone beds: very little shale. |
| — | — | 32.3 | Very prominent spheroidal weathering in sandstone beds. |
| 32.3 | 7.3 | — | Heavy sandstone beds with shaly partings. |
| — | — | 25.0 | Lowest pelecypod bed (*Whitella massanuttenensis,* n. sp., and *W. nasuta,* n. sp., abundant). |
| 25.0 | 15.7 | — | Increase in thickness of sandstone beds. No fossils observed. |
| — | — | 9.3 | Highest typical Eden fauna, containing *Cryptolithus, Sowerbyella, Cornulites.* |
| 9.3 | 9.3 | — | A lithologic transition zone marked by an increase in sandstone. |
| 0.0 | 0.0 | 0.0 | Below this horizon is typical Eden lithology consisting of alternating light and dark beds of sandstone and shale, breaking into small, platy fragments. Eden thickness undetermined. |

PASSAGE CREEK SECTION

| Thickness | | | Description |
|---|---|---|---|
| Total | Interval | Horizon | |
| — | — | 163.3 | Lowest Massanutten sandstone outcrop taken as contact. |
| 163.3 | 55.4 | — | Entirely concealed, largely covered with Massanutten sandstone float. |
| — | — | 107.9 | Spring enclosure on west side of road containing highest Martinsburg outcrop. |
| 107.9 | 12.9 | — | Largely concealed, with a few scattered outcrops. Barren, fine-grained sandstone breaking into flat joint blocks. |
| — | — | 95.0 | Last fossils observed. |
| 95.0 | 11.0 | — | More or less massively bedded, fine-grained sandstone with a few thin beds containing Passage Creek assemblage. |
| 84.0 | 8.0 | — | Massive, fine-grained, gray to brown sandstone. |
| — | — | 80.0 | Extremely prolific 6-inch porous bed in which *Lophospira* is very abundant. |
| — | — | 78.5 | Very conspicuous porous bed. |
| 76.0 | 6.0 | — | A few thin porous beds with *Lophospira* abundant. |
| 7.00 | 6.0 | — | Massive sandstone with hematite particles and a few scattered *Rafinesquina* and pelecypods. Rusty weathering prominent. |
| 64.0 | 10.0 | — | Typical Passage Creek lithologic and faunal zone, containing frequent fossiliferous beds of variable thickness and extent, with *Paractinoceras*, then *Lophospira*, and then *Rafinesquina* conspicuous in ascending order. |
| — | — | 54.0 | At road level, beginning of more or less continuous exposures. Arkosic, fine-grained sandstone, thinly laminated throughout, weathering into blocky beds, speckled with hematite. |
| 54.0 | 54.0 | — | Concealed. |
| 0.0 | 0.0 | 0.0 | Lowest Martinsburg outcrop consisting of brown fine-grained sandstone beds, somewhat arkosic, weathering rusty. *Rafinesquina alternata mediolineata*, n. var., abundant; also *Dalmanella* sp. |

*rhynchula* bed everywhere marks the dividing line between the Lower Maysville (Fairview) and the Upper Maysville (McMillan) divisions, the latter in the Appalachian region being an unfossiliferous, gray sandstone apparently of continental origin and equivalent to the Oswego sandstone of the New York section." In sections already examined elsewhere in the Appalachian region, we have found this *Orthorhynchula* zone usually well developed near the top of the formation (Bassler, 1919, p. 160). In the Massanutten region—specifically, in the Passage Creek section—one depauperate specimen of *O. linneyi* (James) was found. This occurred in the lower part of the Passage Creek Zone, which at the type locality is 106 feet, and at Cub Run about 200 feet, below the top of the Martinsburg.

This paucity of characteristic Maysville forms suggests striking differences in conditions of both environment and deposition between this area and those farther west.

Butts (1940, p. 202) reports the lack of other formations between the Martinsburg and the Massanutten in this region, and we have found neither Juniata nor Oswego beds as such in either of our sections. However, close examination of the Martinsburg of Little North Mountain, which lies between the western sections and Massanutten Mountain, may indicate whether the barren, somewhat cross-bedded, ferruginous sandstone beds lying above the fossiliferous part of the Passage Creek Zone are Martinsburg (Maysville) in age or are to be correlated with either the Oswego or the Juniata, or both, since these latter formations occur on Little North Mountain (Butts and Edmundson, 1939, p. 169). It is evident that the intermittent development of these intervening formations is a problem of such large scope that it is beyond the province of this paper to do more than note their apparent omission in the Massanutten syncline (Butts and Edmundson, 1939, p. 179).

In the two sections under discussion, variations in the lithology of the comparatively barren strata above the Passage Creek Zone suggest the possibility that they may have accumulated under deltaic conditions (Bassler, 1919, p. 161) with the source of the material closer to Cub Run than to Passage Creek. As evidence supporting this theory, the following observations are presented:

1. At Passage Creek the measured thickness of this zone is 68 feet, while at Cub Run it is almost three times as great, being 182 feet.

2. The sandstone beds contain scattered plant remains but no marine fossils.

3. As stated above, there is a striking absence of characteristic Maysville forms.

4. The material at Cub Run is more consistently arenaceous in character than that at Passage Creek.

5. There is a stronger development of cross-bedding at Cub Run than at Passage Creek.

6. At Cub Run the basal Massanutten is somewhat conglomeratic.

## DESCRIPTION OF SPECIES

### BRACHIOPODA

**Rafinesquina alternata mediolineata**, n. var.

Figs. 13, 14

All specimens are internal casts. Shell attaining large size, semioval, the average ratio of width to length for holotype and paratypes being about 1.4 to 1. Dimensions of holotype: width 36 mm, length 30 mm. Hinge line straight, equal to the greatest width of the valve. Cardinal angles rectangular to very slightly mucronate. Ventral valve gently and evenly convex, the beak moderately prominent; costellae small, rounded, and distinct, usually every fourth one more pronounced from the beak to the anterior margin. The pronounced costellae without bifurcations, but bifurcation of the smaller ones common in the anterior half of the valve. The outstanding surficial feature is a very prominent, straight, central costella extending the full length of the valve, but causing no extension of the anterior margin, which is evenly rounded. Faint concentric growth ridges indicated. Dorsal valve same as ventral valve in size and outline; flat, except for a very slight projection of the beak; finely and evenly costellate, lacking the alternations of the ventral valve.

*Locality.*—Passage Creek.

*Remarks.*—The varietal name *mediolineata* has been chosen because of the presence of the very conspicuous median striation on the ventral valve, which is lacking in *R. alternata* (Emmons). In other respects the two are similar.

This variety does not have the mucronate shape of *R. mucronata* Foerste; *R. squamula* James does not exhibit an alternation in the size of the costellae; *R. alternata centristriata* Ruedemann occurs much lower stratigraphically; and in *R. nasuta* (Conrad) the prominent central line is not a constant feature and the anterior margin is noticeably produced.

### MOLLUSCA

#### PELECYPODA

**Byssonychia bowmani**, n. sp.

Figs. 4, 5

Cast of left valve. Shell small. Outline subquadrangular with rounded base. Beak small, rounded in section, acutely pointed, curving forward slightly and extending a short distance beyond the hingeline. Umbone very prominent, expanding evenly toward the entire ventral margin of the shell. Hinge line straight and about two-thirds the greatest length of the shell making an angle of approximately 90 degrees with the anterior margin. Height 32 mm; thickness 10 mm. Anterior outline about straight, the margin projecting slightly at its lower end to form the greatest length of the shell. From this point the ventral margin is strongly and convexly rounded, flattening somewhat as it approaches the posterior cardinal angle. Byssal opening indistinct. Costae fine, rounded, numbering from 65 to 70 and increasing very gradually in strength from the posterior to the anterior margins. Interior not seen.

*Locality.*—Passage Creek.

*Remarks.*—In outline this species is similar to *B. richmondensis* Ulrich, but in the latter the anterior margin is longer and the angle between the hinge line and the anterior margin is greater. Both *B. richmondensis* Ulrich and *B. praecursa* Ulrich are generally more elongate from beak to ventral margin. The specific characters of *B. bowmani* are the great number of costae (65 to 70, as compared with 38 to 42 for *B. precursa* and about 50 for *B. richmondensis*), a shorter anterior margin, and a less elongate shell.

This distinctive species is named in honor of Dr. Isaiah Bowman, president of The Johns Hopkins University.

**Cuneamya umbonata**, n. sp.

Fig. 8

Cast of the interior of right valve. Shell of medium size, having a length of 25 mm and a height of 15 mm, larger at the anterior end and tapering to a rounded posterior point; beak very large, high, pointed and incurved, projecting 2.5 mm above the cardinal line. Apex of beak situated about one-third the length from the anterior end. Cardinal line straight for one-

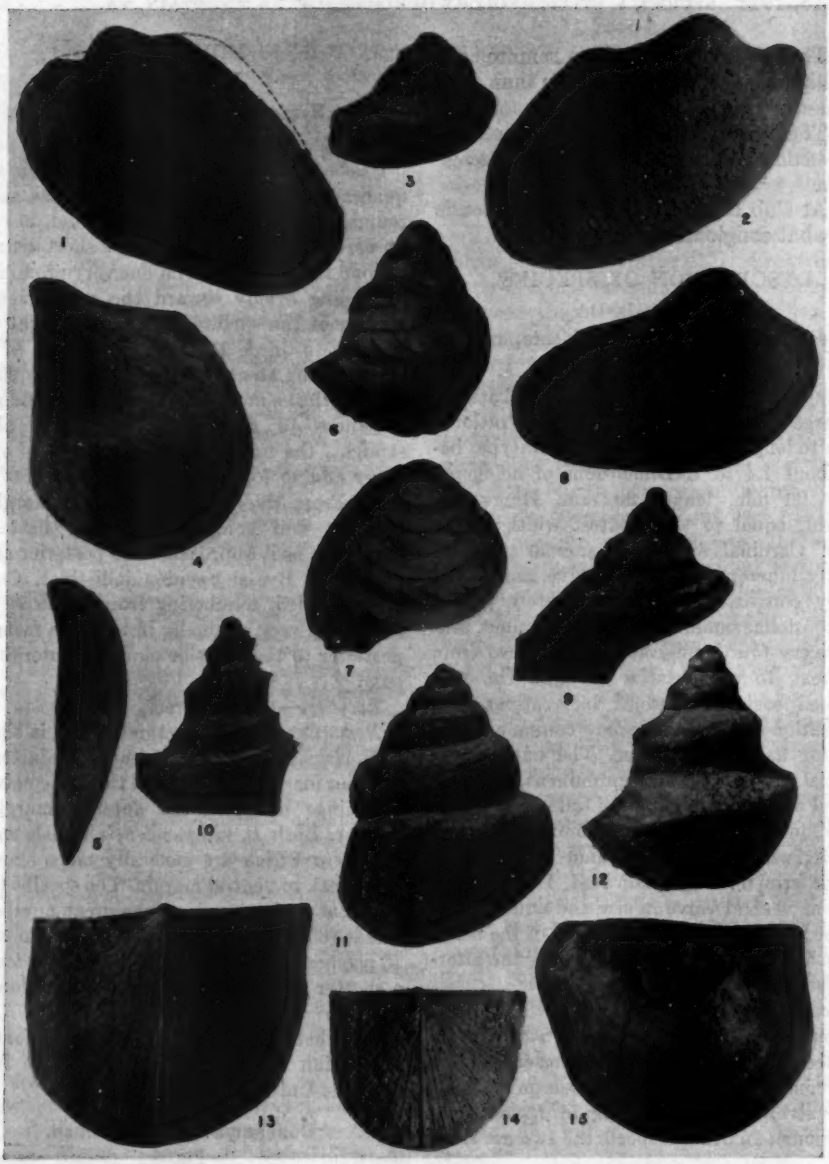

Fig. 1.—*Whitella massanuttenensis*, n. sp., cast of left valve of holotype. Fig. 2.—*W. nasuta*, n. sp., plastic cast of holotype, mold of right valve. Fig. 3.—*Lophospira expansa*, n. sp., cast of interior of holotype. Figs. 4, 5.—*Byssonychia bowmani*, n. sp., cast of left valve of holotype: 4, side view; 5, front view. Figs. 6, 7, 11.—*Lophospira tropidophora* (Meek), plastic casts of interior molds: 6, 7, two views of one specimen; 11, another specimen; all indicating common variations. Fig. 8.—*Cuneamya umbonata*, n. sp., cast of right valve of holotype. Fig. 9.—*Lophospira breviangulata*, n. sp., plastic cast of holotype, mold of interior. Fig. 10.—*L. trilineata*, n. sp., plastic cast of holotype, mold of exterior. Fig. 12.—*L. liosutura*, n. sp., plastic cast of holotype, mold of exterior. Figs. 13, 14.—*Rafinesquina alternata mediolineata*, n. var.: 13, holotype, external cast of ventral valve; 14, paratype, immature specimen. Fig. 15.—*Pterinea maternata*, n. sp., cast of left valve of holotype (umbone broken away, gastropod fragment lodged in opening).

All from Passage Creek except Fig. 2, which is from Cub Run.

half the length of the shell, posterior to the beak; posterior portion of the cardinal area slightly alate. Escutcheon well marked; lunule heart-shaped, distinct. Base of lunule forming anterior point of shell, the ventral margin curving convexly from this point to the posterior extremity. Umbonal ridge rounded, sloping to the posterior point. No trace of a sulcus, a horizontal longitudinal section being at no place concave. A line through the beak, through the widest part of the shell, makes an angle of about 20 degrees with the vertical. Greatest thickness of the valve 15 mm from which it tapers evenly and abruptly to the anterior, and gently to the posterior extremities. Faint concentric growth lines present.

*Locality.*—Passage Creek.

*Remarks.*—The striking prominence and convexity of the umbo distinguish this species from others of the genus.

**Pterinea maternata,** n. sp.
Fig. 15

Cast of left valve. Shell subrhomboidal, exceedingly convex. Hinge line straight, its length being 18 mm. Greatest length of shell 22 mm; height 20 mm; thickness 7 mm. Anterior wing short and broadly rounded. Posterior wing short, triangular, extending a little beyond the margin. Posterocardinal area alate. Beak destroyed. Umbonal ridge not marked, the whole valve having a swollen appearance. Posteroventral and ventral margins evenly rounded. Anterior margin nearly straight and making an angle, if extended, of about 75° with the hinge line.

*Locality.*—Passage Creek.

*Remarks.*—The most distinctive characteristic of this species is its striking convexity.

**Whitella massanuttenensis,** n. sp.
Fig. 1

Cast of left valve. Shell of medium size, very convex, subrhomboidal in outline, slightly the widest posteriorly; length measured from upper anterior to lower posterior angle 43 mm; greatest height 33 mm. Anterior margin gently rounded and nearly vertical in the upper half; sharply rounded at the extremity of the hinge. Ventral margin evenly and gently convex to the posterior extremity of the umbonal ridge. Postbasal angle strongly rounded. Posterior margin subparallel to the anterior margin, moderately rounded at the extremity of the hinge. Beak small and very prominent, not strongly incurved, situated about one-third to one-fourth the length behind the anterior extremity. Umbonal ridge very slightly developed as compared with the majority of the species of the genus. Sinus area slightly flattened in the ventral half of the shell, situated about midway in the length and subparallel to the umbonal ridge. Indications of imbricating and concentric growth lines present.

*Locality.*—Passage Creek.

*Remarks.*—*Whitella compressa* Ulrich is more rounded, compressed, and slightly more erect than this species. *W. obliquata* Ulrich has much stronger umbonal ridges with the beak situated more anteriorly. *W. ohioensis* Ulrich is more rounded in outline and less convex.

**Whitella nasuta,** n. sp.
Fig. 2

Mold of right valve. Shell medium, compressed convex, subrhomboidal in outline, elongate; length measured from upper anterior to lower posterior angle 43 mm; greatest height 28 mm. Widest at the posterocardinal angle. Hinge line almost straight. Anterior area flattened and produced into a rounded front margin. The ventral margin shows an evenly convex curve from the posterior extremity of the umbonal ridge to the anterocardinal angle. Posterior end of shell evenly rounded. Posterocardinal angle very wide. Umbone small, compressed, slightly incurved, protruding moderately above the hinge line. Umbonal ridge very low, disappearing in the posterior third. Umbone situated about one-third the length behind the anterior extremity.

*Locality.*—Cub Run.

*Remarks.*—This species bears a general resemblance to *W. massanuttenensis,* n. sp., but is distinguished by its nasute anterior end and more compressed shell.

GASTROPODA

**Lophospira breviangulata,** n. sp.
Fig. 9

Cast of interior. Apical angle 90°±. Height 8 mm. Volutions no more than 4. Probably tricarinate; all carinae rounded. Toward the aperture there is an indication of a lower carina which seems to fuse with the peripheral one higher in the shell. The upper carina is sepa-

rated from the peripheral one by a distinct but very narrow concave area, the position of which makes the upper slope of the whorl very wide and slightly convex. The last whorl is greatly expanded. Sutures well indented. Whorls compressed longitudinally. Umbilicus and aperture not seen; surface ornamentation obscure.

*Locality.*—Passage Creek.

*Remarks.*—This species is distinguished by the position of the upper carina which causes the slope between it and the suture to be unusually wide.

**Lophospira expansa,** n. sp.
Fig. 3

Cast of interior. Shell medium, volutions 4 to 5. Height 18 mm, diameter 16 mm. Apical angle about 90°. Whorls uniangular. Earlier whorls compressed and rounded, the upper slope being a little greater than the lower. Sutures moderately indented. Last whorl greatly expanded with a prominent rounded peripheral keel. Upper slope slightly concave and of such width as to be in striking contrast to the narrow and rounded surfaces of the earlier whorls which, exclusive of the last whorl, have an apical angle of about 75°. Lower surface of last whorl convex and sloping inward abruptly to the columella, giving the whorl a shallow or compressed appearance in relation to its comparatively great diameter. Surface markings indistinct.

*Locality.*—Passage Creek.

*Remarks.*—This species generally resembles *L. tropidophora* (Meek) but differs from it in the striking expansion of the last whorl.

**Lophospira liosutura,** n. sp.
Fig. 12

Mold of exterior. Apical angle about 50°. Volutions 5. Spire rather elongate. Height 13 mm, diameter of last whorl 9 mm. Peripheral carina prominent. Upper surface of the last whorl flat from the inner margin of the keel approximately to the suture. Inclination of this upper surface very steep. Upper surface of earlier whorls convex and steep. Lower surface of whorls very slightly convex, inclined very steeply, and fused with the upper surface of the next whorl to form a smooth, unbroken sutural curve.

*Locality.*—Passage Creek.

*Remarks.*—This species is distinguished by its smooth sutural curve and rather elongate spire. It compares only in general shape with *L. manitoulinensis* Foerste which is described from the Richmond of Ontario and Quebec. The latter, however, is much larger, having a height of 45 mm, and more closely resembles *L. sumnerensis* (Safford) and *L. tropidophora* (Meek) than does the present species.

**Lophospira trilineata,** n. sp.
Fig. 10

Mold of exterior. Apical angle 30° to 35°. Height 7 mm. Volutions 4; angular. Lower carina, if present, hidden. Central carina on the outer extremity of the volution very angular and prominent having on each side a sharp elevated ridge with a narrow groove between. These ridges are placed a short distance inward along the slopes from the keel, the distance being slightly greater for the upper one. Upper carina removed a third of the width of the slope from the upper suture, and very sharp or angular. Surface of whorl between the keels decidedly concave. There is a rounded ridge intermediate between the sharp upper carina and the suture. Umbilicus and aperture not seen. Surface ornamentation obscure.

*Locality.*—Passage Creek.

*Remarks.*—This species may be compared specifically with those Lophospiras which possess a threefold central carina. *L. trilineata* differs from these in possessing a small, rounded but prominent ridge on the last whorl between the upper carina and the suture. *L. saffordi* Ulrich apparently is more robust and much larger with seven volutions. *L. pulchella* Ulrich and Scofield also is larger. *L. bicincta* (Hall) possesses a much greater apical angle, thus having a shorter and fatter appearance.

**Lophospira tropidophora** (Meek)
Figs. 6, 7, 11

There is a notable lack of agreement between the description and illustrations of this form by Cumings (1907, p. 969) quoting from Meek (1872, p. 278), and those by Ulrich and Scofield, also following Meek (not Miller, see errata p. 1081 of reference). The description given by Ulrich and Scofield (1897, p. 978) follows:

"Height generally from 25 to 35 mm.; greatest width equalling from 75 to 80-100ths of the height; apical angle 75° to 80°. Volutions five, uniangular; base produced, rounded; umbilicus

closed; columellar lip thick and slightly twisted below. Surface markings curved strongly backward to the peripheral band, coarse and rather irregular on the base of the last whorl, much less distinct on the nearly flat upper slope. When perfect the lines of growth are somewhat lamellose."

Our specimens are in general agreement with the foregoing description, but the upper slope of their whorls is concave and the lower slope of the last whorl is more erect.

We have found a number of well-preserved casts of the interior of *L. tropidophora* and one moderately well-preserved cast of the exterior at Passage Creek. The descriptions follow:

*Cast of exterior.*—Shell large. Height 30 mm, width 25 mm. Apical angle 70 to 75°. Volutions 5 to 6. Last whorl very ventricose, the upper portion of the lower slope erect. Whorls uniangular, peripheral carina rounded, prominent and marginal. Upper slope concave; sutural edge distinct but not carinate; suture slightly impressed. On the earlier whorls, the ratio of upper slope to the lower is 2 or 3 to 1, giving a general pagodalike appearance to the shell. Growth lines on upper surface of the whorls are indistinct; on the lower surface of the last whorl they are very coarse, swinging slightly forward from the keel and then curving downward.

*Cast of interior.*—Last whorl very ventricose. The upper slope of the whorls comparatively narrow for the size of the shell; the ratio of its width to that of the lower slope for the last whorl being about 1 to 5. The upper slope is quite concave on the last whorl, less so on the earlier ones, and is crossed diagonally with backward-curving grooves. These are strongest in the midbreadth of the slope, disappearing toward the suture and the keel. The features of the upper slope show considerable variation. The main carina or keel is rounded with a slight edge on the upper surface and is situated a little inside of the greatest diameter of the whorl. The upper portion of the lower slope is comparatively erect and is the greatest diameter of the shell; the lower portion curves convexly inward. The earlier whorls are rounded and slightly compressed in appearance. There is no indication of a lower carina. The sutures are located at such a point that the ratio of the upper slope to the lower on the earlier whorls is about 1 to 1 or 1 to 1.5. Sutural edge slightly thickened but not carinate. The growth lines on the lower slope of the last whorl swing slightly forward from the keel and then curve downward. The lower portion of the inner lip is thickened and reflexed.

## FOSSIL LIST FOR PASSAGE CREEK AND CUB RUN

| Fossil | Passage Creek | Cub Run |
|---|---|---|
| **PLANTAE** | | |
| *Buthotrephis* cf. *B. flexuosa* Hall | | x |
| *B.* sp. indet. | | x |
| *Palaeophycus?* sp. indet. | | x |
| **COELENTERATA—Graptozoa** | | |
| *Diplograptus* cf. *G. vespertinus* Ruedemann | | + |
| *D.* sp. indet. | * | |
| **ANNELIDA** | | |
| *Cornulites* cf. *flexuosus* (Hall) | | + |
| **BRYOZOA—Trepostomata** | | |
| *Bythopora* sp. indet. | * | * |
| *Hallopora* sp. indet. | * | * |
| **BRACHIOPODA** | | |
| *Dalmanella meeki* Miller | *x | *x |
| *D. multisecta* Meek | * | *x |
| *Lingula* cf. *nicklesi* Bassler | | x |
| *Orthorhynchula* cf. *O. linneyi* (James) | * | |
| *Pholidops cincinnatiensis* Hall | | + |
| *Plectorthis* sp. indet. | * | + |
| *Rafinesquina alternata mediolineata*, n. var. | *x | *x |
| *R. alternata* (Emmons) var. | | + |
| *Sowerbyella* sp. | | + |
| *Zygospira modesta* (Hall) | *x | *+ |
| **MOLLUSCA—Pelecypoda** | | |
| *Byssonychia bowmani*, n. sp. | *x | x |
| *B. praecursa* Ulrich | * | x+ |
| *B.* sp. indet. | * | * |
| *Colpomya faba* cf. var. *pucilla* Foerste | | x |
| *Ctenodonta albertina* Ulrich | * | |
| *Cuneamya scapha brevior* Foerste | * | |
| *C. umbonata*, n. sp. | * | |
| *Cymatonota* cf. *phaladis* (Conrad) | * | |
| *C.* sp. indet. | * | |
| *Cyrtodonta* sp. | * | |
| *Ischyrodonta unionoides* (Meek) | | * |
| *I.* sp. indet. | | x |
| *Orthodesma nasutum* (Conrad) | | x |
| *O.* sp. | * | |
| *Pterinea insuela* (Emmons) | * | x |
| *P. maternata*, n. sp. | * | |
| *Rhytimya* sp. | * | |
| *Whitella massanuttenensis*, n. sp. | | x |
| *W. nasuta*, n. sp. | | * |
| **MOLLUSCA—Gastropoda** | | |
| *Liospira vitruvia* (Billings) | * | |
| *Lophospira breviangulata*, n. sp. | * | |
| *L. expansa*, n. sp. | * | |
| *L. tiocutura*, n. sp. | * | |
| *Lophospira medialis* Ulrich and Scofield var. | * | |
| *L. perangulata* (Hall) var. | * | |
| *L. trilineata* n. sp. | * | |
| *L. tropidophora* (Meek) | * | * |
| *Ozydiscus* sp. indet. | | x |
| **MOLLUSCA—Cephalopoda** | | |
| *Paractinoceras lamellosum* (Hall) | * | * |
| *Spyroceras* sp. indet. | * | |
| **ARTHROPODA—Trilobita** | | |
| *Calymene* sp. indet. | * | |
| *Cryptolithus tesselatus* Green | | + |
| *Isotelus maximus* Locke | * | * |
| *I. megistos* Locke | * | |
| *Odontopleura* sp. | | + |
| **ARTHROPODA—Ostracoda** | | |
| *Drepanella richardsoni* (Miller) var. | | * |
| *Ceratopsis chambersi* (Miller) | | + |

*=Passage Creek Zone.
+=Eden.
x=Maysville but not in Passage Creek Zone.

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## BOTANY.—*A new plant of the genus* Onoseris *from Bolivia.*[1] S. F. BLAKE, Bureau of Plant Industry, Soils, and Agricultural Engineering.

The description of a new species of the composite genus *Onoseris* from Bolivia is published here in order to make the name available for a revision of the genus in course of preparation by Sr. Ramón Ferreyra, of the Estación Experimental de la Molina, Ministerio de Agricultura, Lima, Peru.

**Onoseris fraterna** Blake, sp. nov.

Herba valida trimetralis ubique compacte albido-tomentosa, faciebus superioribus foliorum exceptis; caulis striatus supra angulatus medullosus foliosus; folia maxima lyrato-pinnatifida, segmento terminali hastato-deltoideo cordato apice et in angulis acuto, lateralibus paucis oblongo-ovatis multo minoribus, basalibus pluribus minimis; panicula multicapitata pedalis et ultra ramis erectiusculis, pedicellis 1.5–6 cm longis prope apicem inconspicue subulato-bracteatis; capitula radiata ca. 42-flora 2.3 cm alta rubra; involucri 1.8–2 cm alti valde gradati ca. 7-seriati appressi albido-tomentosi phyllaria exteriora minima subulata bracteis apicis pedunculi omnino similia, cetera anguste oblongo-lanceolata ad lineari-lanceolata parum acuminata; corollae marginales 13 bilabiatae hermaphroditae antheris cassis, corollae interiores 29 tubulosae breviter 5-dentatae hermaphroditae; achenia breviter sericeo-pilosa; pappus stramineus.

"Herb 10 ft. high"; stem subterete, 1 cm thick, densely and compactly whitish-tomentose, solid, pithy; leaves (including the narrowly winged petiole) 57–64 cm long, submembranaceous, above bright green, sparsely and inconspicuously hispidulous with short conic hairs, beneath densely whitish-tomentose, the terminal segment 25–27 cm long, about 30 cm wide, repand-dentate with callous-tipped teeth, the lateral divisions about 2 pairs, 3–11 cm long, 2–5 cm wide, acute, repand-dentate, the segments toward base of petiole 7–9 pairs, triangular to linear, acuminate, 1.5 cm long or less; panicle about 50-headed, about 30 cm long and 24 cm wide, the axis and branches strongly angled, densely whitish-tomentose and puberulent with short, purplish, many-celled, not glandular hairs; subulate bracts toward tips of pedicels rather few and inconspicuous, 2–3 mm long, appressed; heads (moistened) campanulate-oblong, about 2.3 cm high, 1 cm thick; phyllaries rather persistently tomentose, more or less denudate on the often purplish margin and the broad median vitta, the latter often finely pilosulous with purplish hairs like those of the pedicels, the middle and inner phyllaries 1.8–2 mm wide; receptacle fimbrillate; marginal corollas crimson, 20 mm long, thinly pilose dorsally, the tubular part 10 mm long, the outer lip spreading, elliptic, 3-denticulate, 10 mm long, 2.5 mm wide, 8–9-nerved, the inner lip entire, narrowly linear, acuminate, revolute, 8 mm long; disk corollas crimson, tubular, cylindric, glabrous throughout, 17.5 mm long (tube 6.5 mm, throat isodiametric with tube, 9.5 mm, teeth 5, triangular, acute, erect, 1.5 mm long); achenes of ray and disk (scarcely mature) similar, subcylindric, 5-ribbed, densely pubescent with erectish hairs, 6 mm long; pappus copious, several-seriate, somewhat graduated, straw-color, of slender hispidulous bristles, 1.5 cm long; anthers of marginal flowers 4, nonpolliniferous, 4 mm long, those of the disk flowers 5,

[1] Received September 6, 1943.

polliniferous, 7 mm long (tails 2 mm, sacs 3 mm, appendages 2 mm; filaments glabrous).

BOLIVIA: San Bartolomé (near Calisaya), basin of Río Bopi, Prov. S. Yungas, Dept. La Paz, alt. 750–900 meters, 1–22 July, 1939, *B. A Krukoff* 10266 (type no. 154679–81, herb. U. S. National Arboretum).

Near *Onoseris silvatica* Greenm., of Costa Rica, and not distinguishable in foliage. In *O. silvatica* the pedicels are conspicuously setaceous-bracted above, and the phyllaries are attenuate with (especially in the outer ones) subsetaceous tips. The geographically nearer *O. purpurea* (L. f.) Blake of Colombia is less closely related, the decidedly setaceous-tipped phyllaries being quickly glabrate except for abundant short many-celled usually purplish hairs. The three species constitute a compact group in this multiform genus characterized by their lyrate-pinnatifid leaves and numerous many-flowered, radiate heads.

## ORNITHOLOGY.—*Critical notes on the avian genus* Lophortyx.[1] HERBERT FRIEDMANN, U. S. National Museum.

### THE GEOGRAPHIC FORMS OF DOUGLAS'S QUAIL, LOPHORTYX DOUGLASII (VIGORS)

Examination of a good series of Douglas's quail, *Lophortyx douglasii*, reveals that there are not two races as currently thought but five.[2] It so happens that all the new forms are fairly southern and are here separated from what has hitherto passed as typical *douglasii*, leaving the northern race *bensoni* undisturbed. The new subspecies, for which none of the names previously proposed in this group seem to be applicable, are as follows:

**Lophortyx douglasii teres,** n. subsp.

*Type.*—U.S.N.M. (Biol. Surv. coll.) 155943, adult ♂, collected at Las Palmas, northwestern Jalisco, March 31, 1897, by E. W. Nelson and E. A. Goldman.

*Characters.*—Similar to *Lophortyx douglasii douglasii* but with shorter wing, 101–104 mm (as opposed to 109–114) in males, 98–102 (as opposed to 105.4–109) in females; with the longest secondaries reaching the tips of the primaries (in *douglasii* the primaries extend 15–20 mm beyond the secondaries) in the closed wing; and with the general coloration darker, the males with the reddish brown on the wings chestnut instead of Sanford's brown (as in *douglasii*), the lower back and rump more brownish; the gray of the breast darker—neutral gray (pale neutral gray in *douglasii*) and the white spots on the abdomen with blackish ringlike edges; the females with the brown on the underparts noticeably darker—dark olive-brown.

*Measurements.*—Five males, including the type: wing 101–104 (102.6); tail 66–72 (68.6); culmen from base 14–14.5 (14.1); tarsus 25–29 (27.8); middle toe without claw 27–29 (28 mm). Three females: wing 98–102 (99.7); tail 65–67 (66.1); culmen from base 13.8–14.3 (14); tarsus 27.5–29 (28.3); middle toe without claw 26–27 (26.3 mm).

*Distribution.*—Northwestern Jalisco (Las Palmas; Las Peñas), possibly to Colima. No specimens, however, appear to have been taken yet in Colima. This State is included in current accounts of the range of the species on the sole basis of Grayson's statement, that he "also found it in the State of Jalisco and Colima, but not as far south as Tehuantepec." (In Lawrence's paper, Mem. Boston Soc. Nat. Hist. 2: 306. 1874.)

**Lophortyx douglasii impedita,** n. subsp.

*Type.*—U.S.N.M. (Biol. Surv. coll.) 157369, adult ♂, collected at San Blas, Tepic, Nayarit June 9, 1897, by E. W. Nelson and E. A. Goldman.

*Characters.*—Intermediate between typical *douglasii* and *teres*, combining the dark coloration of the latter with the wing tip of the former; in size it is entirely intermediate. In other words, *impedita* is a dark Douglas's quail with a noticeable wing tip; this combination of characters sets it off from either of its neighbors. As

[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 6, 1943.

[2] I am indebted to the authorities of the American Museum of Natural History, the Museum of Comparative Zoology, and the California Academy of Sciences for the loan of important comparative material, supplementing that available in the collections of the U. S. National Museum and the Fish and Wildlife Service.

a matter of fact, it is even somewhat darker generally than *teres*.

*Measurements.*—Five males, including the type: wing 105.4–110 (107.9); tail 70–77 (74.2); culmen from base 14–15 (14.5); tarsus 29.5–34.7 (32.3); middle toe without claw 27–30 (28.8 mm). One female: wing 100.5; tail 68; culmen from base 13.5; tarsus 33; middle toe without claw 28 mm.

*Distribution.*—Known only from Nayarit.

**Lophortyx douglasii languens**, n. subsp.

*Type.*—Mus. Comp. Zool. 24975, ad. ♂, collected at Trompa, Chihuahua, January 25, 1885, by R. R. McLeod.

*Characters.*—Similar to *L. d. douglasii* but with the gray of breast less pure gray, lightly washed with brownish, and with indistinct rufescent medioterminal spots on most of the feathers; and with the pale spots on the abdomen slightly buffier, and the pale posteromedian part of the abdomen slightly more extensive.

*Measurement.*—Two males: wing 110–111; tail 77.5–79; culmen from the base 15.5–15.8; tarsus 29–30; middle toe without claw 28.5–29.5 mm.

The separation of *teres*, *impedita*, and *languens* restricts the distributional range of typical *douglasii* to Sinaloa and northwestern Durango (Casa Blanca). The State of Sonora is inhabited by *bensoni*. It may be recalled that van Rossem (Bull. Mus. Comp. Zool., 77 (7): 431–432. 1934) has decided, contrary to some of his own earlier conclusions, that *bensoni* of Sonora and *douglasii* of Sinaloa were not separable and has suggested moving the type locality of *douglasii* from Mazatlan to San Blas. Thus, the resulting *douglasii* of his paper is the bird here described as *impedita*, and his *bensoni* contains both the *bensoni* and the *douglasii* of this paper. It seems to me that he had insufficient grounds for attempting a reinterpretation of the type locality of *douglasii*. What he writes is this: "Regarding Vigors' type of *Ortyx douglasii*, which is in the British Museum; it is doubtful if it ever came from Mazatlan. It is typical, one might say super-typical, of the southern race. The locality as given in the original description was, of course, 'Monterey,' but was later changed by Gambel to Mazatlan. Of course it may have come from Mazatlan, but all things considered, I believe San Blas, Nayarit, to be a better selection. The type is a female, a skin in poor condition and with the tail missing." It would seem from this that it would have been better had van Rossem described the "southern race" as new (equal to my *impedita* plus *teres*) and merely sunk *bensoni* into the synonymy of *douglasii*. However, I can not agree with his conclusion regarding the Sonora-Sinaloa birds either. I find Sonora birds (other than from the extreme southern part of that State) to be distinguishable from Sinaloa examples, and I therefore recognize five races in all.

KEY TO THE RACES OF LOPHORTYX DOUGLASII

*a.* Breast feathers with a scalloped pattern like those of abdomen (females).
  *b.* Crest usually uniform dark sepia to fuscous ..... *bensoni*, ♀
  *bb.* Crest usually spotted or incompletely barred with tawny.
    *c.* Brown of underparts darker—dark olive-brown.
      *d.* With a wing tip (i.e., primaries exceeding secondaries) of 15–20 mm..... ..... *impedita*, ♀
      *dd.* With little or no wing tip.... *teres*, ♀
    *cc.* Brown of underparts paler—olive-brown to pale olive-brown..... *douglasii*, ♀
*aa.* Breast feathers uniform gray, not scalloped (males).
  *b.* Breast very pale—smoke gray, with a faint bluish tinge..... *bensoni*, ♂
  *bb.* Breast darker—light neutral gray or darker.
    *c.* Breast feathers mostly with indistinct pale rufescent terminal spots... *languens*, ♂
    *cc.* Breast feathers mostly with no such spots.
      *d.* With a wing tip of 15–20 mm.
        *e.* General coloration averaging darker, gray of breast and abdomen neutral gray, white abdominal spots more or less ringed with blackish..... ..... *impedita*, ♂
        *ee.* General coloration averaging paler, gray of breast and abdomen light neutral gray, white abdominal spots with no blackish rings..... ..... *douglasii*, ♂
      *cc.* With little or no wing tip..... *teres*, ♂

## A New Race of Gambel's Quail

Gambel's quail reaches its eastern limits in the very arid country of extreme western Texas, in the region about El Paso east to Jeff Davis County. A series of birds from

this area are consistently different in coloration from a long series of the typical race, from southern California, Arizona, Utah New Mexico, and extreme northwestern Mexico, and appear to be a recognizable race, which may be known as—

**Lophortyx gambelii ignoscens,** n. subsp.

*Type.*—U.S.N.M. 9363, adult, unsexed (but male by plumage), collected at San Elezario, Texas, December 1855, by Dr. C. B. Kennerly.

*Characters.*—Similar to *Lophortyx gambelii gambelii* but with the long feathers of the sides and upper flanks lighter in color—between Sanford's brown and chestnut (while in the nominate race these feathers are between chestnut and bay in color) and somewhat paler generally, especially so on the crown, breast, and back.

As in the other races of this species the amount of buffy color on the abdomen can be appreciated only in birds with fairly fresh plumage, as the color seems to bleach out to whitish, even in such a saturated buffy race as *fulvipectus*. The type of *ignoscens* is a bird in fairly fresh plumage; the rest of my specimens of this form are in bleached worn plumage, but the color of the elongated chestnut feathers is quite the same in all. There is no size difference between *ignoscens* and *gambelii*.

*Range.*—The extremely dry desert region, sometimes called the "eastern succulent desert" is inhabited by *gambelii*. A bird from the San Luis Mountain, just within the more arid region, is paler, and agrees with *ignoscens*.

from Fort Fillmore, N. Mex., east to extreme western Texas—El Paso, Belen, San Elezario, and Fort Hancock—east to Presidio del Norte and to the Limpia River, Jeff Davis County. It does not extend farther eastward into Brewster County, and apparently does not go southward into adjacent areas of Mexico, but is limited to the area of low rainfall (under 10 inches a year). Thus, a male from Cajon Bonito Creek, Chihuahua, is *gambelii*. Similarly, in New Mexico its range is restricted to this very arid little belt. Specimens typical of *gambelii* in every way have been examined from the following localities in fairly nearby parts of southern New Mexico: Fort Bayard, Frisco, Garfield, Gila National Forest, Grafton, Joseph, Silver City, and near Tyrone. These indicate that the country to the north of this "eastern succulent desert" is inhabited by *gambelii*. A bird from the San Luis Mountain, just within the more arid region, is paler, and agrees with *ignoscens*.

The characters of *ignoscens* appear to be more pronounced in males than in females, although it must be admitted I have but three females of the new form for study. Two females from Cajon Bonito Creek, northern Chihuahua, are very similar to them, but the male from that locality is definitely *gambelii*. It may be that the two forms intergrade in the area around Cajon Bonito Creek.

Of the new race *ignoscens* I have seen eight males and three females.

## ZOOLOGY.—*A new snake of the genus* Tropidodipsas *from Mexico.*[1] HOBART M. SMITH, University of Rochester. (Communicated by HERBERT FRIEDMANN.)

Among the snakes secured by Thomas MacDougall during the winter of 1941–42 on the Isthmus of Tehuantepec is one belonging to the section of *Tropidodipsas* characterized by the very short head, small posterior chinshields, and small eye. It does not agree with either subspecies of *sartorii* now recognized, the only other members of this section of the genus known from Mexico. I am indebted to Dr. E. H. Taylor for permission to describe it.

**Tropidodipsas macdougalli,** n. sp.

*Type.*—E. H. Taylor–H. M. Smith collection No. 28088, from Tehuantepec, Oaxaca, colert," lected by Thomas MacDougall during January, 1942.

*Diagnosis.*—Related to *T. sartorii*. Dorsal scales in 17 rows, absolutely smooth throughout length of body; black bands 27 on body, 9 on tail, generally a little more than twice length of light interspaces; ventrals 199; caudals 65, in a female; eye diameter about equal to its distance from labial border; head relatively short; posterior chinshields very small.

*Description.*—Head somewhat mutilated. Internasals a little less than half area of prefrontals, their common suture about two-thirds length of common median suture of prefrontals; length of sutures between rostral and internasals about equal to length of sutures between

[1] Received September 15, 1943.

an internasal and a prefrontal, and about equal to a common nasorostral suture; frontal relatively short, about as long as broad, sides smoothly convergent posteriorly and outlining a shield-shaped scale; parietals short, but little longer (6 mm) than broad (5 mm); maximum length of parietals about equal to distance from posterior tip of frontal to internasal-prefrontal suture. Nasal large, divided; loreal square on one side, rectangular on other; latter entering orbit between preoculars; two preoculars, subequal on one side, lower much the smaller on other side; two postoculars, relatively large; temporals 1–2, anterior in contact with both postoculars; supralabials 6–7, third and fourth (fourth and fifth) entering orbit; diameter of orbit equal to distance of eye from labial border; posterior labial about as broad as long, other labials higher than long.

Infralabials 8–9, first in contact on median line; mental small; anterior chinshields about twice as long as broad, in contact with 5–6 infralabials; posterior chinshields indistinguishable.

Dorsal scales in 17–17–17 rows, all perfectly smooth, even posteriorly, pitless; ventrals 199; anal entire; subcaudals 65, divided; female. Total length 697 mm, tail 132 mm.

Body pattern of complete black rings separated from each other by light areas now (late 1942) somewhat pinkish in color (not improbably discolored, as all bands, even at nape, are of the same shade); black rings on body 27, on tail 9, all very slightly narrower laterally than medially; medially the bands are usually a little more than twice as wide as the light interspaces, which generally cover about two scale lengths; on the belly the light interspaces average about as long as the dark rings.

The head is black above, except for a light spot on the posterior angle of the frontal; the color covers the parietals, but laterally extends over only the anterior temporal, anterior half of the penultimate supralabial, and all other scales anterior to these. The mental, anterior three or four infralabials on each side and a spot on each anterior chinshield are black.

*Remarks.*—The single specimen of this form known shows a relationship to *sartorii*, which like it has distinct black rings, 17 scale rows, a very short head, posterior chinshields absent or indistinct, and an essentially similar head scutellation. With *occidentalis* and *philippii*, with 15 scale rows, there is obviously no close relationship. All other species known from or probably occurring in Mexico (*guerreroensis*, *fasciata*, *fischeri*) belong to another section of the genus, characterized by long heads, large eyes, and relatively large chinshields; moreover the patterns of these three species do not correspond with those of *macdougalli*.

From *sartorii* this specimen differs in number of black rings on body (27 as opposed to 13 to 24) and tail (9 as opposed to 4 to 8), number of ventrals (199 compared with 173 to 185), and number of subcaudals (65 in a female as compared with 54 to 63 in the same sex). The keels, which are fairly distinctly evident in *sartorii*, are indistinguishable in this.

Intergradation with *sartorii sartorii* is not improbable; in support of this is a specimen (U.S.N.M. 109908) from Tenosique, Tabasco, with 24-8 black rings; the ventrals (♂) are 180 the subcaudals 66. All other *s. sartorii* examined (8, from Alvarez and Tamazunchale, San Luis Potosí; Potrero Viejo, Veracruz; Emiliana Zapata, Tabasco; and Chuntuquí, Guatemala) have 22-7 black rings or fewer. Regardless of the possibility of intergradation of *macdougalli* and *s. sartorii*, the former is definitely not intermediate in character between the latter and *s. annulatus*, since neither has as many ventrals or dark rings as the new form, although geographically it appears more or less intermediate.

The exact provenance of the specimen is uncertain. It possibly was taken in one of the mountain ranges west or northwest of Tehuantepec, perhaps as far away as 20 miles (straight line). It seems unlikely that the species occurs in the close vicinity of the city of Tehuantepec, since the intensive collecting of recent years has not disclosed its presence there. Nevertheless the latter possibility remains, for the energetic collecting methods of Dr. Joseph R. Slevin has unearthed in the vicinity of Tehuantepec a specimen of another species of *Tropidodipsas*, also unrepresented in the voluminous recent collections from that area.

### Tropidodipsas guerreroensis Taylor

Of considerable interest is a specimen, collected by J. R. Slevin at Mixtequilla, Oaxaca, on August 25, 1925 (Calif. Acad. Sci. 73653). The only other known in United States museums is the type, from Buena Vista, Guerrero.

It is much like the type as described by Taylor (Univ. Kansas Sci. Bull. 26: 470–473, fig. 7, pl. 50, 1939 [1940]). The body is somewhat compressed, the keels on the dorsal scales are rather well defined, the head is relatively elongate, the eyes are large, and the posterior chinshields are nearly half the length of the anterior. As in the type a pair of chinshield-like scales precedes the first ventral, following the other chinshields. The loreal is elongate, separated from eye by the preoculars, which are 2–3 in number; temporals 1–2–2, 1–2–3; supralabials 8–8, infralabials 9–9; the prefrontals are a little larger, about 2½ times as long as internasals. The dorsals are in 17 rows. The ventrals are 184, subcaudals 78. Since the specimen is a male, there are rather prominent knobbed keels above the anus, and numerous small, well-defined tubercles on the chin, throat and extreme anterior part of belly. Total length 603 mm, tail 153 mm.

The markings are much as in the type. The light gular area is not stippled, although the dorsal nuchal band (complete instead of interrupted medially) is finely mottled as in the type. The light bands are narrower posteriorly, most split medially with the halves alternating; they are not broken up into spots as in the type. Most of the dark rings reach the midventer, but only the anterior five are complete since the remainder is staggered; the light bands become wider on the lateral scale rows and on the belly.

The differences from the type exhibited by this specimen are so few that they seem certainly conspecific. The somewhat greater regularity of the dorsal pattern, as well as the lower ventral count, in the Oaxaca specimen suggests more strongly than before a close relationship of *fasciata* and *guerreroensis*. This curious situation, in which a Yucatán form finds its closest relative on the Pacific coast of Mexico north of the Isthmus of Tehuantepec, has a parallel in other snake genera, as for instance *Lampropeltis* and *Stenorhina*. It is not impossible in this case, as in the others, that the forms involved actually intergrade somewhere on the Isthmus.

A number of references to *Tropidodipsas fasciata* (Sumichrast, Arch. Sci. Phys. Nat., 46: 246–247, 249. 1873; and Mocquard, Miss. Sci. Mex., livr. 16: 872–873, pl. 70, fig. 3, 1908) and *Leptognathus fasciatus* (Sumichrast, Bull. Soc. Zool. France 5: 184. 1880; and La Naturaleza 6: 44. 1882) from the Isthmus of Tehuantepec (Santa Efigenía, Cacoprieto) probably are referable to *T. guerreroensis*. The counts given by Mocquard (184 to 186 ventrals) for three specimens from "Mexico" and "Isthmus of Tehuantepec" agree with those of *guerreroensis*, and accordingly his illustrations probably are of that species. The identity of specimens recorded as *Leptognathus fasciatus* from Jicaltepec, Córdoba and San Andrés Tuxtla, Veracruz (Sumichrast, La Naturaleza 6: 44. 1882; and Ferrariperez, Proc. U. S. Nat. Mus. 9: 183. 1886) remains in doubt, but may well be correct. I can find no references in the literature that might apply to *T. macdougalli*.

## ICHTHYOLOGY.—*Review of the genera of blennioid fishes related to* Ophioblennius.[1] EARL D. REID. (Communicated by LEONARD P. SCHULTZ.)

During the past few years I have attempted to identify certain blennioid fishes from the tropical Atlantic and Pacific Oceans. Many of these specimens were not identifiable with forms referred to the genus *Ophioblennius*. As the material was assembled and studied, it became more apparent that a review of this group of genera was needed. This report is a summary of my findings, based on material in the collections of the United States National Museum.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received July 30, 1943.

After carefully studying all the available material related to *Ophioblennius*, the following key was prepared, giving the salient characters that I have concluded are most useful in recognizing the various genera:

1*a*. Gill openings not restricted, forming a free fold across isthmus.
  2*a*. Strongly hooked canine teeth in front of upper and lower jaws.
    3*a*. Ventral fins composed of a concealed spine and two rays; lateral line incomplete.....*Ophioblennius* Gill
    3*b*. Ventral fins composed of a concealed spine and four rays; lateral line complete or nearly so, a few pores lacking posteriorly.....*Leoblennius*, n. g.

2*b*. Canine teeth absent in upper jaw, four strongly hooked canines near symphysis of mandible; lateral line very short ..... *Blenniella*, n. g.

1*b*. Gill openings restricted, the membrane attached to and not forming a free fold across isthmus.

4*a*. Four strongly hooked canine teeth in front of both jaws; gill openings restricted, membrane attached near base of lower pectoral ray..... *Gloriella* Schultz

4*b*. Canine teeth absent in upper jaw, a single series of conical teeth directed forward with a tendency to flare outward; gill openings wider but restricted, width of isthmus about equal to diameter of pupil ..... *Giffordella* Fowler

## Genus **Ophioblennius** Gill

*Blennophis* Valenciennes, *in* Webb and Barthelot, Îles Canaries, Poiss., 1843, p. 60, name preoccupied (*B. webbii* Valenciennes).

*Ophioblennius* Gill, Proc. Acad. Nat. Sci. Philadelphia 12: 103. 1860 (genotype: *B. webbii* Valenciennes); substitute for *Blennophis* Valenciennes, not *Blennophis* Swainson, a genus of Clinidae.

The genus *Ophioblennius* is widely distributed in the tropical Atlantic along the west coast of Africa and from the West Indies to Trinidad. In the Pacific it occurs from the coast of southern California to the Galápagos, Chile to the Marquesas, and the Hawaiian Islands. No species, so far, has been found away from the island or group of islands from which the type was recorded. Most of the specimens as yet collected have been attracted to an electric light and captured in a dip net when this equipment was used from the ship's side while at anchor.

I find the dermal filaments, number of rays in the vertical and paired fins, and length of the lateral line among the characters studied most reliable for specific distinction. The recurved canine teeth at the symphysis of the jaws and the naked body together with the usually forked caudal fin will serve as characters for field recognition of *Ophioblennius* and related genera.

*Description.*—Body oblong, compressed, scaleless; snout short, high, abruptly decurved anteriorly. Lateral line incomplete, vertical fins long, dorsal composed of spines and soft rays, a notch at point of differentiation, anal similar to soft dorsal with two spines, dorsal and anal fins usually free from caudal, the latter lunate or forked. Upper jaw with 2 or 4 strongly hooked canine teeth on the premaxillaries followed by a single series of minute conical teeth loosely attached to the gums and easily movable, these teeth grouped into units of several teeth each and spaced at short intervals so that each group appears as a single deeply incised tooth with 5 to 8 cusps. Lower jaw with 4 strongly hooked canine teeth near symphysis of the mandible, the outer pair more or less horizontal, their tips strongly bent or hooked toward the rictus, usually 1 or 2 curved canines at about midlength of the mandible, the posterior much the larger. Gill openings wide, free from the isthmus, the membrane forming a free united fold across latter in front of the insertion of the ventral fins. Ventral fins composed of a hidden spine and 2 rays. A strongly marked genus, perhaps allied to *Blennius*.

### KEY TO THE SPECIES REFERRED TO OPHIOBLENNIUS

1*a*. Four strongly hooked canine teeth in front of upper and lower jaws.

2*a*. Pectoral fins short, not reaching origin of anal fin.

3*a*. Dorsal XII, 19 or XII, 20; anal II, 20 or II, 21.

4*a*. Nape with a pair of tentacles on each side of midline..... *ferox* Beebe and Tee Van

4*b*. Nape without tentacles on each side of midline..... *watsoni*, n. sp.

3*b*. Dorsal XVI, 20; anal 26 (probably II, 24) ..... *trinitatis* Ribeiro

2*b*. Pectoral fins long, reaching well past origin of anal fin.

5*a*. Dorsal spines X to XII.

6*a*. Dorsal spines XII.

7*a*. Anal II, 22 or 23; dorsal XII, 22 or XII, 23.

8*a*. Color brownish, a black ocellus on preopercle behind eye, caudal fin with longitudinal dark stripes..... *steindachneri* Jordan and Evermann

8*b*. Color pallid, a dark area at occiput and a dark vertical bar at base of caudal fin... *pinchoti* Fowler

7*b*. Anal II, 14 or 15.

9*a*. Dorsal soft rays 16; anal II, 15.

10*a*. A pair of tentacles at the nape on each side of midline, pectorals black, tipped with coarse punctulations..... *xiphiodon* Clark

10*b*. A comb of tentacles at nape on each side of midline, color pallid.. *fernandezensis* Clark

9*b*. Dorsal soft rays 12 to 14; anal II, 14 or II, 15.

11*a*. Dorsal XII, 13; fringe of tentacles at nape gray-black; notch in dorsal fin shallow, less than half length of first soft ray. . . *vanderbilti* Fowler

11*b*. Dorsal XII, 13; fringe of tentacles at nape pale; dorsal fin with a definite space between spines and soft rays . . . . . *clarki*, n. sp.

6*b*. Dorsal spines X.

12*a*. Dorsal soft rays 13; anal 14 (probably II, 14). . . . *phalacrus* Clark

12*b*. Dorsal soft rays 20; anal 20. . . . . *webbii* Valenciennes

5*b*. Dorsal XIV, 20; anal 21 (probably II, 21); no tentacles at nape. . . . . *lanieri* Seale

1*b*. Two strongly hooked teeth on premaxillaries and four similar canines at symphysis of mandible; a fringe of 28 tentacles extending across nape, fringes pale, dorsal notched nearly to base of fin; dorsal XII, 13; anal II, 14. . . . . *capillus*, n. sp.

**Ophioblennius ferox** Beebe and Tee Van

*Ophioblennius ferox* Beebe and Tee Van, Zoologica 10(1): 242–244, fig. 1928 (Haiti); Longley, Carnegie Inst. Washington Yearbook 32: 293–295. 1933 (name only).

U.S.N.M. 120028, 8 examples, 40 to 45.4 mm, Fort Landing, Saba Island, D. W. I., April 11, 1937; Smithsonian-Hartford Exped. Coll., Dr. Waldo L. Schmitt. U.S.N.M. 120029, 2 specimens, 44 to 45 mm, St. Eustatius, off Orangested, D. W. I., April 12, 1937, Smithsonian-Hartford Exped. Coll., Dr. Waldo L. Schmitt.

*Description.*—The standard lengths in millimeters are 45; 44; 42.8; 45; 43.5; 45.4; 43.4; 41.4; 40; 42, respectively. The following measurements are expressed in hundredths of the standard lengths, respectively: Head 22.2; 24.1; 24.1; 23.4; 22.5; 21.8; 23.3; 23.0; 22.7; 23.8. Depth 20.5; 22.7; 21.0; 20.0; 20.5; 19.6; 20.7; 20.5; 19.0; 21.2. First dorsal spine 12.7; 13.6; 12.6; 13.3; 12.6; 13.0; 12.7; 12.3; 13.0; 13.1. Depth caudal peduncle 7.8; 7.5; 7.5; 7.3; 7.4; 7.1; 8.1; 7.7; 8.0; 7.6. Length of snout 6.0; 6.6; 7.0; 5.6; 6.2; 5.7; 6.2; 6.5; 6.2; 6.0. Interorbital 5.1; 5.5; 5.6; 5.1; 5.1; 4.8; 5.1; 5.3; 5.5; 5.5. Diameter of eye 6.7; 6.8; 6.8; 6.7; 6.4; 6.4; 6.5; 6.8; 7.0; 6.9. Pre-anus[2] 46.7; 45.5; 46.5; 47.4; 43.6; 46.7; 46.1; 48.1; 46.8; 46.2. Pre-dorsal[2] 24.2; 23.6; 23.8; 23.3; 24.4; 22.9; 23.7; 24.7; 23.8; 25.2. Length pectoral fin 18.7; 20.0; 19.4; 19.6; 19.6; 19.6; 19.7; 19.6; 19.3; 20.0. Base of anal fin 46.4; 48.2; 47.2; 47.6; 49.0; 48.4; 47.4; 46.9; 46.2; 49.3.

D. XII, 19 or 20; A. II, 20 or 21; P. 15; 15; Br. 5. Body moderately elongate, compressed, the profile convex before eyes, nearly straight from orbits to origin of dorsal fin, which is slightly behind the posterior margin of the preopercle, spines and soft rays of about equal height, the fin with a moderate notch at juncture of spines and soft portion, tips of last rays of vertical fins reaching nearly to caudal base, the peduncle notably deeper than long, anal similar to soft dorsal and preceded by two small spines. Caudal fin moderately forked, the lobes about even, its length about four-fifths that of the pectoral, the tips of which reach about opposite to, or fall a trifle short of, the anus, upper rays of pectoral rather weak, the first about equal to eye diameter, the following rays evenly graduated to the tenth or eleventh, which are longest, the lower rays are somewhat thickened. Ventrals I, 2, inserted well in advance of pectoral base, their tips reaching about opposite tip of lower pectoral ray or midway to the anus. Upper jaw nonprotractile, upper lip attached to snout anteriorly. Four strongly recurved canine teeth on the premaxillaries, followed by a single series of minute conical teeth set in groups of six or seven and loosely attached to the gums and easily overlooked. Mandible with four similar canines at the symphysis, the outer pair nearly horizontally deflected outward, their tips directed toward the rictus, these followed by one or two pairs of curved canines about midlength of the lower jaw, the mandible sharply compressed to a coulterlike edge and forming an angle just behind the lateral canines. Lips thin, closely adhering to the jaws, lower jaw slightly included, the gape small, little oblique, maxillary reaching anterior edge of pupil. Gills 4, a small pore behind last, gill rakers 14, small acute points. Pseudobranchiae developed. Nostrils well separated, the anterior about midlength of snout digitate with six graduated filaments, the longest reaching hind rim of posterior nostril, which is situated just before vertical through anterior rim of eye. Orbital tentacle simple, equals pupil diameter, nape with a pair of filaments on each side of midline about one-fourth length of orbital tentacle. Lateral line incomplete, arched

[2] Distance from tip of snout to anus or tip of snout to dorsal origin.

high over pectoral and ending below anterior rays of soft dorsal.

Color in alcohol light straw generally, lips and occiput with dark bluish shade, dark points forming a shaded area across occiput in front of dorsal and a sprinkle of brownish pigment inside gill cavity, at base of vertical fin rays and a dark shade or dot at base of caudal rays, forming a dark line that fails to reach the upper and lower margins of the fin. Peritoneum silvery but profusely dusted with dark pigment showing through the ventral surface of the abdominal wall as a dark area from base of ventral fins to anus.

*Remarks.*—This species differs from *watsoni* in having a pair of filaments on either side of the midline at the nape.

**Ophioblennius watsoni**, n. sp.

Fig. 1

*Blennophis webbii* Steindachner (not of Valenciennes), Sitzb. math.-nat. Classe Akad. Wiss. **56**(1): 354. 1867 (Barbados).

*Holotype.*—U.S.N.M. 89614, Anse à Galets, La Gonave Island, Haiti, W. I., March 22, 1930, standard length 46 mm. Coll. Watson M. Perrygo. Paratype: U.S.N.M. 120097, same data as holotype. Standard length 44 mm.

*Description.*—The following measurements are expressed in hundredths of the standard length, respectively: Head 21.5; 22.7; depth 17.6; 20.9; first dorsal spine 12.8; 12.5; depth caudal peduncle 6.5; 6.8; length of snout 5.0; 5.5; interorbital space 4.35; 5.0; pre-anus 43.5; 43.0; predorsal 22.8; 22.9; length of pectoral fin 20.9; 19.1; base of anal fin 48.5; 45.9.

D. XII, 19 or 20; A. II, 21; P. 15; 15. V. I, 2. Br. 5. Body naked, oblong, compressed. Profile convex, rather steep from upper lip to above eye, then nearly straight with oblique elevation to origin of dorsal fin, which is situated just before upper angle of gill opening. Dorsal spines slightly lower than soft rays, the fin with a shallow emargination at juncture of differentiation, the posterior spine notably weaker than those preceding, the posterior ray weak, terminating about midlength of the caudal peduncle, which is slightly longer than deep. Anal similar to soft dorsal, the rays preceded by 2 spines. Caudal fin forked, the lower lobe a trifle longer than the upper, about equal to length of pectoral fin which reaches to vertical of the anus, the rays graduated from the upper which is very feeble to tenth which is longest, lower rays somewhat thickened. Ventrals inserted below posterior margin of the preopercle, their tips reaching anterior third of pectoral. Upper jaw nonprotractile, the upper lip free laterally, gape small, oblique, maxillary terminus below anterior margin of the pupil. Four strongly retrocurved canines on the premaxillaries, behind which is a series of minute conical teeth in groups of 7 or 8 teeth each, these units appearing to the unaided eye as single, deeply incised teeth with a short interval between each group, they are loosely attached to the gum and movable. Lower jaw with similar dentition, the outer pair of canines near symphysis of mandible deflected and partly concealed by the lower lip, a small canine about midlength of the mandible and a large curved canine immediately following. Gill rakers very small, 16 on the anterior arch. Pseudobranchiae developed. Nostrils well separated, the anterior with a digitate appendage, posterior nostril above anterior rim of the eye. Orbital filament very small, simple, its length about one-third pupil diameter. Nape without filaments. Lateral line incomplete terminating below third dorsal ray.

Color in alcohol light straw generally, upper lip with dark pigment, a dark shade transversely at occiput, some faint dark spots at base of dorsal fin supports and a dark vertical line at base of the caudal rays, not extending to the rudimentary elements, anal fin translucent. Gill cavity with dark specks, peritoneum silvery with dark pigment. Abdomen from insertion of ventral fins to just before vent with silvery sheen dusted with dark pigment.

*Remarks.*—This new species may be differentiated from all others referred to the genus *Ophioblennius* by means of the key on page 374. It is distinguished from *ferox* by the absence of filaments at the nape.

Named *watsoni* in honor of the collecter, Watson M. Perrygo, of the United States National Museum.

**Ophioblennius trinitatis** Ribeiro

*Ophioblennius trinitatis* Ribeiro, Arch. Mus. Nac. Rio de Janeiro **22**: 177, fig. 1. 1919 (Trinidad).

*Description.*—Head ¼ in the standard length. Dorsal XVI, 20; anal II, 24; ventral I, 2. Depth 4–4.5; mouth small, reaching vertical through anterior rim of the orbit. Four strongly hooked canine teeth on the premaxillaries and four similar canines at symphysis of the mandi-

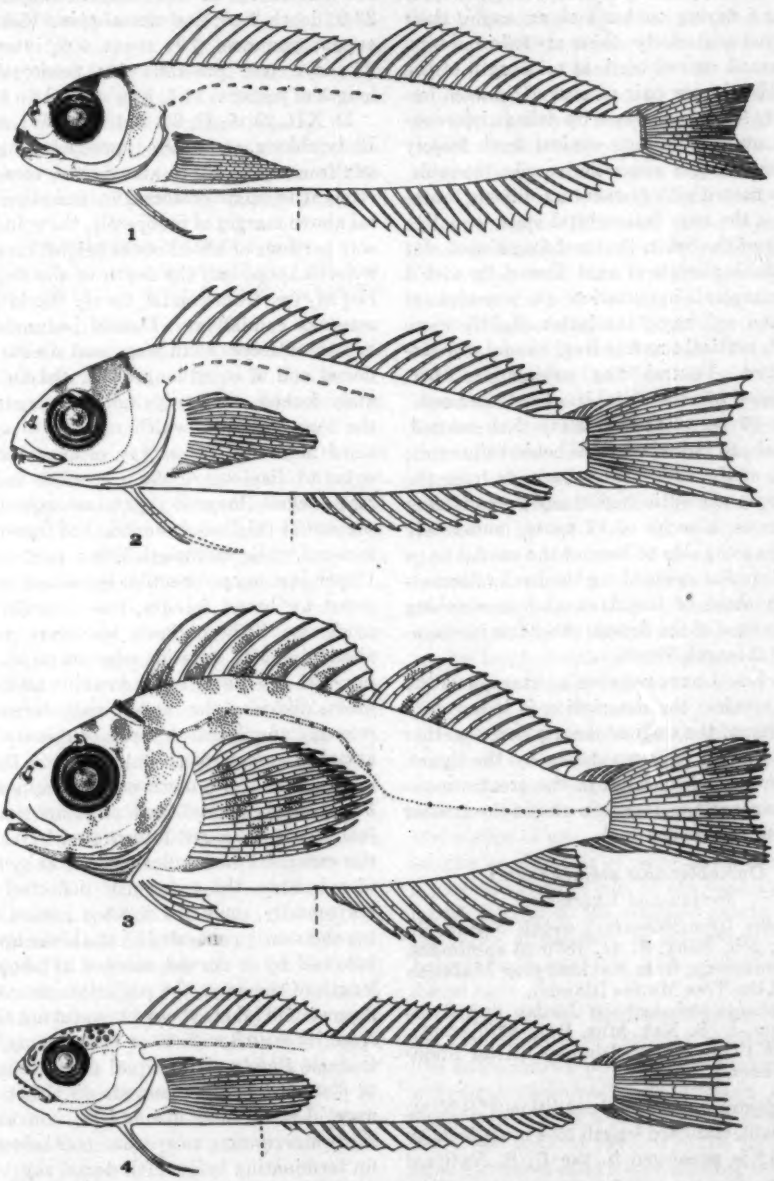


Fig. 1.—*Ophioblennius watsoni*, new species: Holotype (U.S.N.M. 89614), 46 mm. in standard length. Fig. 2.—*Ophioblennius capillus*, new species: Holotype (U.S.N.M. 120032), 21.8 mm. in standard length. Fig. 3.—*Leoblennius schultzi*, new genus and species: Holotype (U.S.N.M. 118037), 25.4 mm. in standard length. Fig. 4.—*Blenniella rhessodon*, new genus and species: Holotype (U.S.N.M. 118029), 22.6 mm. in standard length. Drawn by Mrs. Aime M. Awl, U. S. National Museum.

ble, the inner pair recurved, the outer pair larger and flaring outward at an angle, their tips curved posteriorly; these are followed by a pair of small curved teeth at midlength of the gape and a larger pair of curved canines immediately following. Upper lip delicately crenulated, a series of minute conical teeth loosely implanted on the gums and easily movable. Anterior nostril with filaments, a filiform tentacle above the eye. Interorbital space equal to diameter of the orbit. Pectoral fin pointed, not quite reaching origin of anal. Dorsal fin with a slight marginal indentation at juncture of spines and soft rays, the latter slightly more elevated, vertical fins free from caudal, the latter forked. Ventral fins subjugular, their length equal to postorbital length of the head.

Color (3 per cent formalin) flesh-colored, eyes black, an indistinct stain behind the orbit; a streak of the same color descends from the neck across the optic region and spreads over the isthmus; a series of 11 spots, moderately dark, along the side to base of the caudal fin; a series of similar spots along the back, alternating with those of the flank and encroaching upon the base of the dorsal; other fins immaculate. Total length 52 mm.

*Remarks.*—I have not seen an example of the present species; the description is based on a translation of the original description, together with additional features shown by the figure. Differs from *steindachneri* in the greater number of spines in the dorsal fin and in the greater number of rays in the anal.

### Ophioblennius steindachneri

Jordan and Evermann

*Blennophis* (*Ophioblennius*) *webbii* Steindachner, Ich. Beitr. 8: 41. 1879 (5 specimens, 70 mm. long, from Navidad near Mazatlán and the Tres Marías Islands).

*Ophioblennius steindachneri* Jordan and Evermann, U. S. Nat. Mus. Bull. 47(3): 2401. 1898 (Tres Marías Islands). (After Steindachner.)

A single example in good condition, U.S.N.M. No. 120030, standard length 59.4 mm., locality doubtful,[3] is preserved in the U. S. National Museum.

*Description.*—The following measurements are hundredths of the standard length: Head 23.2; depth 20.6; first dorsal spine 13.5; depth caudal peduncle 6.9; snout 5.6; interorbital 3.7; eye 6.9; pre-anus 43; predorsal 20.5; length of pectoral 24.4; base of anal fin 49.5.

D. XII, 23. A. II, 23. P. 15; 15. V. I, 2. Br. 5. Body oblong, compressed, profile strongly convex from upper lip to above eyes, then nearly straight to origin of dorsal fin. Insertion of dorsal above margin of preopercle, the spinous and soft portions of about equal height, divided by a notch about half the depth of the fin, posterior ray free from caudal, its tip reaching rudimentary caudal rays. Caudal peduncle about one-third deeper than long, anal similar to soft dorsal and of equal length. Caudal fin moderately forked, outer rays notably shorter than the long pectoral, which reaches to opposite third anal ray, upper ray of pectoral about equal to diameter of the eye, ninth and tenth rays longest, lower 6 rays much stronger and somewhat thickened. Ventral fins inserted well forward, their midlength below pectoral base. Upper jaw nonprotractile, lip joined to tip of snout by broad frenum, free laterally. Gape moderate, little oblique, maxillary reaching about opposite anterior edge of pupil. Upper jaw with 4 strongly hooked canine teeth on the premaxillaries, the outer pair largest and strongly angulated. A series of minute loosely attached conical teeth implanted on the gums in groups of 7 or 8 teeth each and appearing as 5 or 6 deeply incised teeth on either side of the jaw, this series is not interrupted by the anterior canines. Four similar canines at symphysis of mandible, the outer pair deflected almost horizontally, their tips directed toward the rictus and nearly concealed by the lower lip. These followed by 2 curved canines at about midlength of the gape, the posterior one much the longest. Gill rakers about 12 (count not certain). Anterior nostril with 10 or 11 filaments, orbital tentacle simple about equal pupil diameter, 5 or 6 small hairlike filaments on either side at nape. Lateral line incomplete, convex anteriorly and running an eye diameter below dorsal fin terminating below fifth dorsal ray.

Color in alcohol dark chocolate generally, a dark ocellus on upper region of preopercle behind eye, outer caudal rays somewhat lighter.

*Remarks.*—This specimen agrees very well with the description of *steindachneri* and probably was taken on the west coast of Mexico by

[3] This bottle contained a mixture of west coast fishes and an old label: "Paraguay, Bahia. Dr. E. Palmer." These specimens probably were obtained in the Gulf of California during Dr. Palmer's visit to the mouth of the Colorado River.

Dr. E. Palmer. It was found in a bottle with five other blennies labeled "Paraguay, Dr. E. Palmer." Although Dr. Palmer collected in Paraguay and in the Gulf of California, the present specimen obviously could not have been taken in the southern locality.

This species is very close to *pinchoti* but has an entirely different color pattern. Other differences are indicated in the key on page 374.

### Ophioblennius pinchoti Fowler

*Ophioblennius pinchoti* Fowler, Proc. U. S. Nat. Mus. **80**(6): 13–14, fig. 3. 1932 (Galápagos)

*Holotype.*—U.S.N.M. 91819, 1 specimen, Black Beach Anchorage, Charles Island, Galápagos Islands, June 27, 1929, A. K. Fisher.

*Paratypes.*—U.S.N.M. 91820, same data, 16 cotypes.

*Other specimens.*—Four additional examples collected as follows: Marchena Island Anchorage, Galápagos Islands, December 3, 1934, 3 specimens, W. L. Schmitt, U. S. N. M. 101930; Tagus Cove, Albemarle Island, Galápagos Islands December 9, 1934, 1 specimen, W. L. Schmitt.

*Description.*—Of 11 examples measured, the standard length in mm. is 45; 45.1; 43.4; 42.3; 42.4; 40.8; 40; 39.6; 35.9; 39; 47. The following measurements are expressed in hundredths of the standard length, respectively: Head 25.1; 24.9; 25.8; 24.6; 24.8; 24.3; 24.5; 25.5; 26.7; 24.9; 26. Depth 22; 22.6; 22.6; 20.6; 20.3; 19.4; 19.3; 18.2; 15; 18.5; 21.3. First dorsal spine 13.8; 12.2; 12.7; 13; 13.5; 13.2; 13.3; 11.9; 14.5; 13.8; 10.6. Depth caudal peduncle 7.8; 8; 8.1; 8.3; 7.5; 7.6; 7.8; 7.6; 8.1; 7.2; 7.4. Length of snout 6.4; 6.4; 6.5; 6.1; 6.8; 6.1; 5.8; 6.1; 5.6; 6.4; 7.4; Interorbital width 5.8; 6; 6; 5.4; 5.2; 5.1; 6.5; 5.1; 5.6; 6.2; 5.3. Diameter of eye 7.1; 7.5; 7.8; 7.3; 7.5; 7.8; 8.5; 8.1; 8.1; 8.2; 7.9. Pre-anus 44; 42.6; 43.1; 40.7; 40.6; 41; 39.3; 41.7; 39.6; 40.6; 44.2. Predorsal 22.7; 23.3; 24.9; 24.1; 24.8; 24.3; 22.5; 24.2; 24.5; 25.1; 23.4. Length of pectoral fin 23.1; 22; 23.5; 23.4; 22.4; 23.3; 26; 22.8; 22.8; 21.8; 25.1. Base of anal fin 48.2; 48.6; 48.6; 53.2; 52.4; 50.7; 53.5; 50.8; 54.3; 51.8; 47.4.

D. XII, 22 or 23. A. II, 22 or 23. P. 15, 15 or 16, 16. Br. 5. Body oblong, compressed, profile of snout from upper lip to posterior nostril strongly convex then nearly straight to origin of dorsal fin, which is slightly behind occiput, spinous portion of dorsal fin a little lower than soft rays, the juncture marked by a moderate notch, tip of last ray about reaching midlength of the caudal peduncle which is slightly deeper than long, anal similar to soft dorsal and of equal length, preceded by two spines, caudal fin forked, about equal to length of pectoral which reaches to opposite third anal ray. Upper rays of pectoral fin much shorter and weaker than lower rays which are long and somewhat thickened, the fifth and sixth rays longest. Ventral fins advanced, their insertion well in front of pectoral base, their tips reaching midlength of the latter or slightly more than half way to first anal spine. Upper jaw nonprotractile the upper lip free laterally. Four strongly hooked canine teeth at front of upper jaw, their tips pointing backward, the outer pair a trifle largest, vomer and palatines toothless. Lower jaw with four similar canines, the outer pair flaring outward nearly horizontally with their tips strongly bent toward the rictus and partly concealed by the lower lip, easily detected by passing the finger forward along the edge of the mandible, these are followed by a minute curved canine tooth about midlength of the gape immediately behind which is a long curved canine tooth, largest of the group. Gills four, a small pore behind last, rakers minute, 22 on first arch, pseudobranchiae well developed. Nostrils well separated, the anterior about midlength of snout supporting a digitate appendage on the inner edge with 8 filaments, posterior nostril just before perpendicular through anterior edge of eye, orbit with a simple tentacle as long as diameter of pupil. Four to six small filaments on either side of the nape about one-fourth as large as the orbital tentacle, their attachment alternately in a semi-double row. Lateral line incomplete, terminating below fifth dorsal ray.

Color in alcohol light straw generally, upper lip with some dark pigment, occiput, lateral line and a narrow strip on either side of dorsal with light chestnut-brown pigment, this very dense and forming a pronounced crescentic line across the back at the occiput, a narrow dark band at base of caudal fin excluding the middle, and the outer 2 or 3 rays above and below, a dark spot at base of the supports of the vertical fins. Peritoneum silvery with a sprinkle of chestnut colored pigment spots.

*Remarks.*—This species is close to *steindachneri* but differs in color pattern.

**Ophioblennius xiphiodon** Clark

*Ophioblennius xiphiodon* Clark, Proc. California Acad. Sci., ser. 4, 22(7): 483–484. 1938 (Peru).

A paratype of this species, U.S.N.M. 120026, was taken at Callao, Peru, in February, 1935, by the Templeton Crocker Expedition 1934–35.

*Remarks.*—Distinguished from *pinchoti* in the fewer supports in the vertical fins and in color pattern.

**Ophioblennius fernandezensis** Clark

*Ophioblennius fernandezensis* Clark, Proc. California Acad. Sci., ser. 4, 22(7): 184. 1938 (Juan Fernández Island).

A paratype of the present species, U.S.N.M. 120027, taken at San Juan Bautista (Cumberland) Bay, Juan Fernandez Island, January 31, 1935, by the Templeton Crocker Expedition 1934–35.

*Remarks.*—Very close to *xiphiodon* but differs strongly in the plain coloration and in the tentacles at the nape.

**Ophioblennius vanderbilti** Fowler

*Ophioblennius vanderbilti* Fowler, Acad. Nat. Sci. Philadelphia Monogr. 2: 242–243, pl. 11, figs. 26, 27. 1938 (Oahu and Christmas Islands).

I quote Fowler's description: "Depth 4 to 4⅓; head 3¼ to 3⅓, width 1⅓ to 2. Snout 4 to 4⅓ in head; eye 2¾, greatly exceeds snout or interorbital; maxillary reaches ⅓ to ½ in eye, length 3 in head; 4 canines in front of each jaw, each greatly bent or arched, each outer lower one flaring outward nearly to right angle; interorbital 3⅓ to 3¾ in head, broadly convex. Gill opening forms free fold over isthmus.

"Body with smooth scaleless skin. Lateral line incomplete, superior, only running back as far as end of depressed pectoral. Fringed supraorbital flap nearly as long as pupil. Short nasal flap. Fringe of short filaments in single row transversely across occiput.

"D. XII, 13 or 14, third spine 2⅔ to 2¾ in head, third ray 1⅔ to 2; A.14,[4] fin height 2⅓; caudal 1, slightly emarginate; least depth of caudal peduncle 2⅔ to 2¾; pectoral 1 1/10 to 1⅓ rays 13; ventral 1⅔ to 1¾ in head.

"Color of body russet, little paler on chest, breast and prepectoral, also on belly. Head drab nearly ecru drab below. Iris gray to silvery white. Supraorbital filament and row of nuchal filaments gray black. Fins all light or pale brown, dorsals and anals grayish terminally."

*Remarks.*—This species is not represented in the national collections. Distinguished from *capillus* by the much shallower notch in the dorsal fin and by the grayish-black coloration of the dermal appendages.

**Ophioblennius clarki,** n. sp.

*Ophioblennius* sp. indet. Clark., Proc. California Acad. Sci., ser. 4, 22(7): 185. 1938 (Marquesas).

*Description.*—The present study indicates that Clark's undetermined specimen is a valid species. A single example was taken at Taiohae Bay, Nukuhiva Island, Marquesas, October 6–15, 1934. I quote Clark's description:

"Total length 32 mm.; body 26 mm.; head (9 mm.) 2.88 in head; depth (8) 3.25; eye (3) in head; snout (2) 4.5; maxillary (2.5) 3.6; interorbital (2) 4.5; D. XI-13, the spines long and slender, a short space between spinous and soft dorsal; A. I, 15[5]; V. 2, the rays long and slender; P. 16, base broad; C. truncate; branchiostegals about 4, gill membranes forming a fold across the isthmus a little anterior to base of ventrals; jaws about even. Two strong and markedly curved canines at symphysis of upper jaw, followed by two smaller ones; a pair of similar, strongly curved canines at symphysis of lower jaw; no secondary canine immediately behind it, but there appears to be a small one back at the posterior part of the jaw. About 27 muscular bands; no scales, but an arched lateral line of about 27 pores over the pectoral and backward. No color except the usual black area over the occiput; a small silvery patch on belly. A branched cirrus at nostril, a slender single one above eye, and comb of filaments at nape."

*Remarks.*—This species differs from *capillus* in having a definite space between the spinous and soft portions of the dorsal fin. No doubt there are XII spines in the dorsal instead of XI as given by Mr. Clark.

Named *clarki* in honor of the late H. Walton Clark, curator of fishes, California Academy of Sciences, San Francisco.

**Ophioblennius phalacrus** Clark

*Ophioblennius phalacrus* Clark, Proc. California Acad. Nat. Sci., ser. 4, 22(7): 184–185. 1938 (Nukuhiva).

[4] Probably this count is II, 14.

[5] Probably this count is II, 15 or II, 14.

I quote Clark's description: "Total length 32 mm.; body 26 mm.; head (9 mm.) 2.88 in body depth the same; eye (3) 3 in head; snout (2) 4.5; maxillary (2.5) 3.6; gape hardly reaching to eye; interorbital (2) 4.5; D. X, 13; A. 14; V. 2; P. 19; no scales, but lateral line short, arched over pectoral, the pectoral rather short, but broad. Branchiostegals 5, gill-membranes forming a shallow fold across the isthmus; caudal truncate or slightly emarginate. Teeth as usual in the genus, four stout, curved fangs about symphysis of upper and lower jaws, a palisade of small incisors in sides of jaws.

"Color: Posterior part of body cream color; head coarsely punctate with black spots, the largest of which are larger than pupil, the spots extending backward along base of dorsal."

*Remarks.*—Not represented in the national collections. Distinguished from all known representatives of the genus in the absence of dermal appendages and in the separate dorsal fins.

### Ophioblennius webbii (Valenciennes)

*Blennophis webbi* Valenciennes, *in* Webb and Bathelot, Îles Canaries, Poiss., pp. 60–61. 1839 (Fort Ventura, Canary Islands); Günther, Cat. Fish. Brit. Mus. **3**: 259 1861 (Canary Islands).

*Blennius webbii* Poggi, [article in Guidebook of Canary Islands], "Guia de Santa Cruz de Teneriffe" [p. d. 35]. 1881 (Canary Islands)

*Blennophis webbii* Vinciguerra, Atti Soc. Ital. Sci. Nat. **34**: 321. 1892 (Canaries).

*Ophioblennius webbii* Fowler, Bull. Amer. Mus. Nat. Hist. **70**(2): 1052–1053, fig. 434. 1936 (Tropical Atlantic) (Valenciennes); Norman, *Discovery* Rept. **12**: 56. 1936 (Ascension Island).

*Blennophis webbianus* Valenciennes, op. cit. pl. 20, fig. 3 *a–c*.

*Blennophis webbi* Günther, Rept. Voy. *Challenger* **1**: 5. 1880 (Ascension Island).

*Remarks.*—I have seen no example of this species, and its occurrence in the Western Atlantic is doubtful. It differs from all known American species in having fewer dorsal spines and from all Western Atlantic forms in the much longer pectoral fins.

### Ophioblennius lanieri Seale

*Ophioblennius lanieri* Seale, Allan Hancock Pacific Expeditions **9**(1): 40, pl. 4, fig. 4. 1940 (Galápagos).

*Remarks.*—The present form is not represented in the national collections. An error occurs in the reported number of dorsal spines as given in the original description, but plate 4, figure 4 by Seale (l. c.) is correct in this respect. Dr. W. M. Chapman, curator of fishes at the Academy, has kindly reexamined the holotype and reports 14 spines in the dorsal fin. The present form is distinguished from *pinchoti* in possessing a greater number of spines in the dorsal fin and lacking filaments at the nape.

### Ophioblennius capillus, n. sp.

Fig. 2

*Holotype.*—U.S.N.M. 120032, *Albatross* Station 3921, night anchorage off Honolulu, T. H. Diamond Head Light, S. 62°, E. 3.9′, May 6, 1902, surface, electric light. Standard length 21.8 mm.

*Description.*—The following measurements are expressed in hundredths of the standard length. Head 29.4. Depth 21.6. First dorsal spine 16.1. Depth caudal peduncle 10.6. Length of snout 6.9. Width of interorbital 7.8. Diameter of eye 10.6. Pre-anus 45.8. Pre-dorsal 30.7. Length of pectoral fin 25.7. Base of anal fin 39.0.

D. XII, 13. A. II, 14. P. 15, 15. V. I, 2. Br. 5. Body oblong, compressed, scaleless, profile gently convex from upper lip to nape, a weak depression at occiput and a slight keel in front of dorsal fin. Insertion of dorsal above midlength of opercle, the spines a little higher than soft rays, the fin divided at point of transition by a deep notch, the last spine attached by membrane to the lower sixth of the first soft ray, posterior ray reaches rudimentary caudal elements. Anal similar to soft dorsal, the fin terminating pupil diameter short of lower caudal elements. Caudal peduncle slightly longer than deep, caudal fin lunate, equal length of head. Pectoral fin long, reaching opposite base of second anal ray, lower rays little thickened. Ventral fins inserted through vertical of occiput, reaching ⅔ distance to vent. Lips thin, free laterally. Upper jaw nonprotractile, maxillary, reaching to below anterior margin of pupil. Upper jaw with 2 strongly hooked canine teeth on the premaxillaries, followed by 5 or 6 groups of minute conical teeth concealed in the lips. Lower jaw with 4 similar canines at symphysis of mandible, the outer pair nearly horizontal and strongly hooked toward the rictus, the apex concealed in the lip, a very small pair of canines about midlength of the mandible easily overlooked and exposed only by depressing the

gum. Gill rakers obsolete. Anterior nostril with a bifurcate appendage, orbital appendage trifurcate, the middle filament longest. Nape with a transverse series of fringes crossing the midline, 28 filaments in the series. Lateral line incomplete arched above the pectoral terminating below anterior dorsal rays.

Color in alcohol light straw generally, a russet shade across occiput, some dark pigment along base of dorsal fin, abdomen from base of ventrals to anus with a silvery sheen, dermal appendages colorless.

*Remarks.*—Differs from *Ophioblennius vanderbilti* Fowler in having only two canines in the upper jaw, more rays in the pectoral fins, nasal and orbital appendages, and in the much deeper notch in the dorsal fin. Other differences will be found in the key on page 374.

Named *capillus* in reference to the hairlike row of filaments across the nape.

**Leoblennius, n. g.**

*Description.*—Body scaleless, moderately elongate, compressed, the back somewhat elevated. Vertical fins moderate, composed of spines and soft rays. Dorsal fin with a notch at juncture of differentiation. Ventral fins jugular, formula I, 4. Pectoral fins large, reaching past anal spines. Branchiostegal rays 5. Gill openings wide, free, forming a moderate fold across the isthmus. Gill rakers in moderate number. Teeth all conical, 4 strongly hooked canines on the premaxillaries and 4 similar canines at symphysis of mandible. Upper jaw nonprotractile, lips free laterally. Anterior nostrils orbits and nape with dermal appendages, the latter with a series of filaments crossing the midline. Lateral line complete or nearly so, arched anteriorly over the pectoral fins, several pores missing posteriorly.

A well-marked genus of tropical blennies whose affinities seem to be close to *Gloriella* on the one hand and *Ophioblennius* on the other, but differing from the former in the character of the gill openings and from the latter in having 4 rays in the ventral fins.

*Genotype.*—*Leoblennius schultzi*, n. sp.

**Leoblennius schultzi, n. sp.**

Fig. 3

*Holotype.*—U.S.N.M. 118037, *Albatross* Station 3921, night anchorage off Honolulu, T. H., Diamond Head Light, S. 62°, E. 3.9′, May 6, 1902, surface, electric light. Standard length 25.4 mm.

*Paratype.*—U.S.N.M. 120096, same data as holotype. Standard length 26.0 mm.

*Description.*—The following measurements are expressed in hundredths of the standard length, respectively: Head 32.7; 31.9. Depth 32.7; 31.2. First dorsal spine 19.3; 18.5. Depth caudal peduncle 11.4; 11.5. Length of snout 9.84; 9.2. Width of interorbital space 11.8; 10.8. Diameter of eye 11.4; 11.2. Pre-anus 50.4; 53.8. Pre-dorsal 28.7; 29.6. Length pectoral fin 27.5; 30.4. Base of anal fin 38.2; 38.1.

D. XII, 13. A. II, 15. P. 15; 15. V. I, 4. Br. 5. Body scaleless, oblong, compressed, rather short and deep in comparison with other members of the present group. Dorsal profile well arched, convex from upper lip to above posterior nostril then oblique to origin of dorsal fin which is above preopercle margin. Dorsal spines notably higher than soft rays, the fin divided by a deep notch, last spine joined to first ray by membrane at lower ¼, last ray attached to caudal peduncle by membrane just before base of upper rudimentary rays of caudal fin, peduncle much deeper than long. Anal fin similar to soft dorsal, last ray free of membrane posteriorly and failing to reach lower caudal rays by pupil diameter. Caudal fin emarginate, its length about equal that of pectoral which reaches to above base of fourth anal ray, its outline symmetrical, lower rays very little thickened. Ventrals inserted below second dorsal spine, their tips reaching midlength of the pectoral fin. Upper jaw nonprotractile, lips free laterally, mouth small gape to below anterior rim of orbit. Four strongly hooked canine teeth at tip of upper jaw and four similar canines near symphysis of mandible, the outer pair deflected outward, no lateral canines evident at midlength of lower jaw. Gill rakers very minute, about 14 on lower arch, pseudobranchiae developed. Nostrils well separated, the anterior with a small, flat terminally fringed filament, orbital tentacle compressed, flap-like, short and blunt, a fleshy band across the nape almost connecting the lateral lines, the margin of which supports 32 filaments or fringes, slightly decreasing in length terminally. Lateral line conspicuously arched above the pectoral fin, its posterior portion indistinct with several pores missing along axis of body. Muscular impressions distinct posteriorly, about 18 from above vent to hypural.

Color in alcohol yellowish generally, a dusky band across occiput and a similar band across nape just before the band of cirri and joining the posterior rim of the eye, a small dusky area on lateral line below fourth dorsal spine, one on midline before dorsal fin, and a series of dusky shades along the back extending up on the membrane between first and second spines with transparent membrane between third and fourth spines, the color scheme alternating throughout length of the fin, gradually fading out on the soft rays. There are two dusky bands across the pectoral fin and a small black spot near the tip of each ray conspicuously marks the outline of the fin, three russet shades on opercle and a dash of the same color downward from lower rim of the eye, orbital tentacle dark at base, tip lighter, fringes on the nape plain yellowish, no dark pigment on upper lip nor at base of caudal fin.

*Remarks.*—This new species differs from all related species as indicated in the key on page 374.

I take great pleasure in naming this interesting species in honor of Dr. Leonard P. Schultz, curator of fishes, United States National Museum.

**Blenniella**, n. g.

*Description.*—Body scaleless. Dorsal with 13 spines, a deep notch between spinous and soft portions. Gill openings free from the isthmus. Teeth all conical, arranged in groups of 6 to 8 each; teeth of the units graduated the anterior tooth of each unit longest, the posterior one shortest; each group appearing as a deeply incised tooth with 6 to 8 minute cusps arranged step-fashion, as viewed laterally; lower jaw with similar teeth and in addition 4 strongly retrocurved canines at symphysis of mandible. This genus is intermediate between *Ophioblennius* and *Giffordella*. It is distinguished from the former by the absence of canines in the upper jaw and from the latter by the unrestricted gill openings.

*Genotype.*—*Blenniella rhessodon*, n. sp.

**Blenniella rhessodon**, n. sp.

Fig. 4

*Holotype.*—U.S.N.M. 118029, *Albatross* Station 3921, night anchorage off Honolulu, T. H. Diamond Head Light, S. 62°, E. 3.9′, May 6, 1902, surface, electric light. Standard length 22.6 mm.

*Paratypes.*—U.S.N.M. 120031. Standard lengths 21.4 to 22.7 mm.

*Description.*—Seven examples were measured and their standard lengths in mm. are as follows: 22.6; 22.6; 22.7; 21.4; 22.0; 21.4; 21.9. The following measurements are expressed in hundredths of the standard length, respectively: Head 21.2; 20.8; 21.1; 19.7; 21.4; 23.4; 22.4. Depth of body 16.8; 15.5; 15.0; 15.5; 15.8; 15.9; 15.5. Height first dorsal spine 9.74; 10.2; 10.6; 10.3; 9.56; 11.2; 9.6. Depth caudal peduncle 7.5; 7.5; 7.9; 8.0; 6.8; 6.5; 8.2. Length of snout 4.4; 4.4; 4.84; 4.7; 4.54; 5.14; 5.0. Interorbital width 5.75; 6.2; 6.17; 6.6; 5.9; 5.6; 5.94. Diameter of eye 8.4; 8.4; 7.93; 8.9; 8.2; 7.94; 8.68. Pre-anus 40.1; 41.6; 42.3; 43.2; 42.7; 43.4; 43.8. Pre-dorsal 22.1; 22.6; 22.0; 23.0; 21.8; 22.4; 22.4. Length pectoral fin 25.7; 27.0; 26.9; 29.1; 27.3; 27.6; 26.5. Base of anal fin 43.8; 44.7; 45.4; 46.4; 45.4; 46.2; 46.6.

D. XIII, 19. A. II, 20. P. 13; 13 or 13; 14. V. I, 2. Br. 5. Body naked, oblong, compressed, rather slender, back not elevated, profile of snout gently convex before eyes, slightly oblique to origin of dorsal then nearly straight to caudal base. Origin of dorsal fin above midlength of opercle. Spines little lower than soft rays, the fin divided by a deep notch nearly to its base, last ray attached to peduncle by membrane and not quite reaching upper supplemental rays of caudal fin. Anal similar to soft dorsal but not extending quite so far back, the last ray free from peduncle which is slightly longer than deep. Caudal fin truncate or weakly emarginate its length about equal to that of the head. Pectoral fin long, reaching to above third anal ray. Ventral fins inserted below midlength of opercle and in contact with the membranous fold across the isthmus, their extremity reaching half the distance from their base to the vent. Gape small, lips free laterally, the maxillary reaching nearly to opposite center of pupil. Teeth in the upper jaw minute, conical disposed in groups of 6 to 8, the anterior tooth of each group notably longer than the posterior tooth, the intervening teeth graduated, the apexes of the teeth in each unit forming an oblique edge. These groups form a continuous series in the upper jaw, about 6 units on either side. Lower jaw with similar teeth and in addition 4 strongly hooked canines near the symphysis of the mandible, the outer pair horizontal, their apexes directed posteriorly and somewhat concealed by the lower

lip. Gill openings free, forming a fold across the isthmus, gill rakers minute, 12 on anterior arch, pseudobranchiae developed. Anterior nostril with a simple filament, orbital filament simple, nape without cirri. Lateral line high, terminating below posterior dorsal spines. Twenty-four myomeric impressions between anus and hypural.

Color in alcohol light straw generally, immaculate except upper surface of the head where the postfrontal region is sprinkled with minute black dots. The occipital region has slightly larger black spots surrounded by circles of chestnut brown, giving the impression of small bull's-eyes or targets.

*Remarks.*—This new species can be recognized from other related genera of blennoid fishes by the key on page 374.

Named *rhessodon*, ragged tooth, in reference to its uneven dentition.

### Genus **Gloriella** Schultz

*Gloriella* Schultz, Copeia 1941(1): 17–18. 1941.

Four strongly hooked canine teeth on the premaxillaries and a single series of small conical teeth not interrupted by the canines. Four similar canines near symphysis of the mandible. Gill openings restricted laterally, not extending below base of lower pectoral ray. Lateral line incomplete. Nape with a fringe of cirrus extending across the midline; anterior nostril with a fringe of tentacles. Caudal fin rounded, the middle rays longest. Other characters those of the genotype.

*Genotype.*—*Cirripectes caninus* Herre.

#### **Gloriella canina** (Herre)

*Cirripectes caninus* Herre, Philippine Journ. Sci. **59**(2): 284. 1936 (type locality: Ternate Island, Moluccas); **70**(4): 342. 1939.

### Genus **Giffordella** Fowler

*Giffordella* Fowler, Proc. U. S. Nat. Mus. **80**(6): 14, fig. 4. 1932 (Nukuhiva Island, Marquesas Islands) (genotype: *Giffordella corneliae* Fowler).

#### **Giffordella corneliae** Fowler

*Giffordella corneliae* Fowler, Proc. U. S. Nat. Mus. **80**(6): 1–16, fig. 4. 1932 (Marquesas).

Original description: "Depth 4 to 4⅓; head 3¾ to 4; width 1¼ to 1⅓; snout 3 to 3⅓ in head; eye 2⅓ to 3 in head, greater than snout to subequal with interorbital; maxillary reaches back ⅓ to ¼ in eye length, 2⅓ to 2¾ in head; teeth rather large, simple, conic, curved, uniserial in jaws and lower as 10 flaring outward each side; interorbital 3 to 3⅓ in head, well convex. Gill openings large, extends forward about opposite hind eye edge, isthmus width about half eye. Body scaleless. No flaps or tentacles.[6] Lateral line not evident, side medianly with axial longitudinal impression. D. 14, 14, fin height about ⅔ of head and divided by deep median notch, a little behind vertical of anal original; A. 14, each membrane notched terminally, fin height about one-half of head; caudal slightly less than head, hind edge slightly emarginate; least depth of caudal peduncle 2 to 2⅔ in head; pectoral slightly longer than head, lower median rays longest, reaches little beyond anal origin; ventral nearly long as head, of 2 simple rays.

"Largely transparent brownish or colorless. Dark pigment spots on cranium. Iris silver gray to white.

"*Type.*—U.S.N.M. 91821, collected near light, Nukuhiva, Marquesas Islands, September 25, 1929. Also 11 paratypes, same data, 16 to 22 mm.

"Named for Mrs. Cornelia Bryce Pinchot, first lady of Pennsylvania."

[6] In connection with the present studies, the holotype of *Giffordella corneliae* Fowler, U.S.N.M. 91821, was reexamined and the following characters (not mentioned in the original description) were observed: Anterior nostril with a small simple filament on the inner edge, a well-developed simple orbital tentacle attached to the membrane of the eye superiorly, and a single similar filament at the occiput on either side of the midline. Four small strongly hooked canines near symphysis of the mandible, the outer pair more or less horizontal. Lateral line distinct anteriorly with 5 or 6 pores. D. XII, 14; A. II, 14; P. 14.

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